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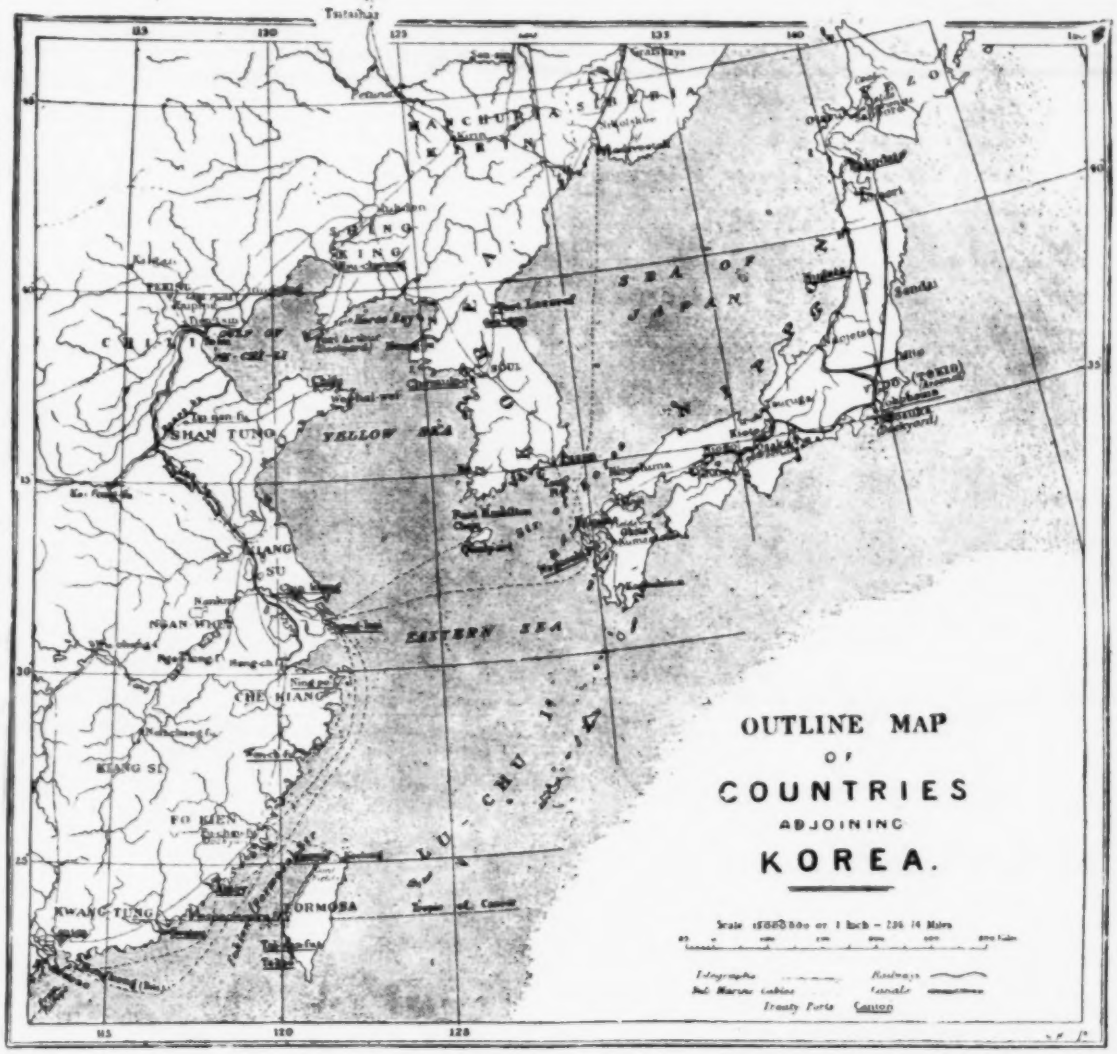
SOME CURIOUS COREAN CUSTOMS.

BY A CORRESPONDENT OF THE LONDON TIMES.

THE Coreans are perhaps of Japanese stock, but China has been for centuries their wet nurse and their schoolmistress. No two Oriental peoples are more essentially unlike than are the Chinese and the Japanese; and the Coreans, resembling the Japanese in many respects but living under conditions largely Chinese and deeply imbued with Chinese ideas, present a picture peculiarly quaint even in the quaintest part of the world. They have Japanese faces, Chinese customs, and a manner of their own. But into their Chinese-like customs some little Japanese habit has crept now and again. And the Coreans have even ventured, once in a while, to invent a custom of their own.

I remember being especially interested in the Corean sign-posts and in the Coreans' methods of heating their houses. I do not know which was more original, more strictly Corean, the sign-posts or the peculiar furnaces by means of which the Corean houses were made habitable through the long, bitter Corean winters.

Every Corean house has a cellar, not for the storing of wine, but for the storing of heat. The cellar is called a khan. Its mouth, through which it is fed, is some distance from the house. On a cold night you will see one or more white clad figures cramming the khan's mouth, as fast as they can, with twigs, branches, and other combustible food. Once well fed, the furnace burns for hours and keeps the house warm all night. So the attendants of the fire are not kept out in the cold very long; and while they are there their hands are full of work. A Corean house heated at sunset keeps warm all night, because the fire is invariably huge, because the floors through which the heat permeates are made of oiled paper, and because the furnace itself is largely a mass of pipes and flues that both retain and give out heat. With almost no exceptions, the houses in Corea are one-storied. So simple a scheme of domestic architecture enables so simple a scheme of house heating to be thoroughly efficacious. Europeans sleeping for the first time in a Corean house usually complain that in the middle of the night the heat is too intense, and the atmosphere insupportable, and that toward the chill hours of early morning, when the fire has died and the pipes at last grown cold, the room is most disagreeably cold. But



THE SCENE OF HOSTILITIES BETWEEN JAPAN AND CHINA.

CHEFOO, THE PRINCIPAL CHINESE PORT ON THE YELLOW SEA.—FROM A DRAWING BY MR. W. SIMPSON.

these are minor matters, and far too trivial to disturb Corean slumber. Next to the Eskimos, the Coreans are the heartiest eaters in the world. So, naturally enough, they sleep profoundly. It used to seem to me that they were always eating; and nothing short of a royal edict or a bursting bombshell will interrupt a Corean feast. I regret to say that the flesh of young dogs is their favorite viand. Japanese beer is their favorite beverage. And for this, let me commend them. For never in Milwaukee, never in Vienna, have I drunk beer so good as that which is made at the Imperial brewery in Tokio. Like all other Orientals, they devour incredible quantities of fish; herrings for a first choice. The herrings are caught in December and are not eaten until March. Watermelons are the fruit most plentiful and most perfect in Corea. They are superb. Potatoes were in disgrace, under the ban of a royal edict, when we lived in Corea. They had been introduced into the country shortly before ourselves, and their general use might have done much to alleviate the horrible famines which visit Corea with a cruel regularity. But their use and their culture were forbidden. Only in the less disciplined outskirts of the peninsula were they to be had. We used to send many miles for ours and then eat them in safety only because of the red, white, and blue flag that sheltered our bungalow from the too scorching rays of the Eastern sun.

But about the sign-posts in Corea—they are extremely quaint! Each sign post is shaped like an old fashioned English coffin, and it is topped by a face, a very grotesquely painted, a very Corean, a very grinning, but for all that a very human face. They used to rather startle me at first, when I came round the corner of a country road and found them smirking at me in the grewsome moonlight. But I grew used to them, for they were all alike. They all wore the countenance of Chang Sun, a great Corean soldier. Chang Sun lived one thousand, more or less, years ago. His life was devoted to the opening up of his country to the feet of his countrymen. He intersected the hills of Corea with pathways, and to-day, from every signpost, he beams upon every Corean wayfarer. Beneath his beaming face you may (if you are learned enough) read his name; you may read, too, where the road or roads lead, how far the next settlement is, and one or two other items that are presumably of general interest to the Corean traveling public.

There are neither inns nor hotels in Corea. But the rest houses are neither few nor far between. A Corean rest house is a species of dak bungalow. It does not fulfill our jaded European ideas of luxury, but it answers the purpose of the Corean traveler very fairly well. He can cook there. He can eat there. He can sleep there. He can buy Japanese beer there. The average Corean is a sensible fellow and wants nothing more. No—I am wrong; he wants two things more. He wants to compose poetry and to paint pictures. The Coreans are a nation of poets and of painters. Every fairly educated man writes poems and paints pictures. But there is nothing to prevent him doing either or both inside or outside the Corean rest house. The majority of Coreans are highly educated, as Corean education goes, and in many ways it goes very far indeed.

In Corea, as in China, a man's social position depends upon the prestige he can establish for himself at competitive examinations. In Corea, as in every other normal quarter of the globe, a woman's social position depends upon the social position of her husband. The examiners in the Corean competitive examinations are said to be bribable and corruptible. Very possibly; most human institutions are fallible. Even Achilles had a heel. But certainly Corea has been for centuries and centuries a country where scholarship took precedence of everything but kingship; a country where education was esteemed above common sense. High time, some people may think, that we swept such a country from off the face of our nice, new, utilitarian nineteenth century!

The Coreans have their faults. They have a great many faults. And they are weak. Reasons and to spare why they should be exterminated.

All the Corean animals are very small, but very strong. The peninsula abounds in tigers, bears, cows, horses, swine, deer, dogs, cats, wild boars, alligators, crocodiles, snakes, swans, geese, eagles, pheasants, lapwings, storks, herons, falcons, ducks, pigeons, kites, magpies, woodcocks and larks. Hens are plentiful and the eggs are delicious. But the natives do not make half the use one would expect of all this feathered plenty. Goats may be reared by no one but the King, and are exclusively used for religious sacrificial purposes.

The Coreans are good to their children and to all animals. Snakes and serpents are, perhaps, treated by them with more veneration and tenderness than any other form of animal life. No Corean ever kills a snake. He feeds it and does everything else he can to conduce to its comfort. The poorest and the hungriest Corean will share his evening meal with the reptiles that sneak and crawl about the rocks that bound his garden. Ancestral fire is a very important thing in Corea. In every Corean house burns a perpetual fire, which is sacred to the dead ancestors of the household. To tend that fire, to see that it never runs the least risk of going out, is the first—the most important—duty of every Corean housewife. In Corea, as in China, ancestor worship is the real religion. Confucianism is the avowed religion of the country; but, like the Chinese, the Coreans hold dogmatic religions in considerable, good-natured contempt.

Fortune tellers and astrologers are as many and as prosperous in Corea as in China. Like the Japanese, the Coreans have found a special and profitable vocation for their blind. In Japan the needy blind invariably practice shampooing. In Corea the blind exorcise devils and in analogous ways make themselves generally useful. Their dealings with the evil spirits are summary and thorough. The gifted blind man frightens the devil to death by means of diabolical noises, or catches the devil in a bottle and carries it in triumph to a place of safety where devils cease from troubling and afflicted Coreans are at rest.

The laws of Corea are explicit concerning high treason. They smite it hip and thigh. They exterminate it root and branch. If a Corean is found guilty of high treason, he dies, and his entire family dies with him. In this custom the Coreans are again Chinese, and not altogether un-Japanese. No Corean dare utter his King's name. When the King dies he is given a name (a kind of name, an apology for a name) by which his august personality may be distinguished amid the dense masses of history. But his real name, the name he bears in life, is never spoken save in the secrecy of the palace harem. And even there it is only spoken by the privileged lips of his favorite wife and his most spoiled children. To touch the King of Corea with a weapon or instrument of metal is the highest treason. The minds of the Corean kings, as well as the hands of the Corean people, are so kept back by this law, King and people obey this law so entirely, that 94 years ago Tieng-tsong-tai-dang allowed an abscess to end his life rather than permit a subject to touch with a knife even a diseased portion of his body.

The constitution of the Corean Home Office is based upon the Japanese system. The Foreign Office is modeled on the Chinese Foreign Office. At the head of the War Office is the "Pan So," or Decisive Signature, an official of very great power. Under him are several lesser officials, called "Cham Pau," or Help to Decide. Under these are men called "Cham Wi," or Help to Discuss; and again under these are a number of secretaries. But, alas! in the present Oriental imbroglio (although Corea is nominally the causa belli) the Corean War Department is playing a part so insignificant that we do not even hear of it.

A COREAN MINISTER.

THE illustration showing this dignified minister of state in the city of Seoul, the capital of the Corean kingdom, borne upon an open litter through the streets to perform an official visit, and the banquet, prepared and served in the European style, with sufficient champagne, with which he regales the foreign resident diplomatists, are supplied by photographs taken in 1887 by Col. Chaillé Long, then United States Consul-General at Seoul. The Corean Minister of Foreign Affairs at that time was Cho-Pyong-Sik, a courteous old gentleman of sixty-five, who hospitably entertained his guests at table, where, during the first part of the dinner, each sat between an interpreter and a female dancer, but the women retired when the eating was done, leaving the gentlemen, as in Europe, to their wine and talk. At a later hour they passed into the courtyard to witness an exhibition of rope dancing and a ballet performed by eight girls, who were not very pretty, but decorous and slow in their movements, wearing ample skirts. The present minister at the "Oi-a-mun," or Foreign Office, is not the same person. In 1891 it was Prince Ming-Yuen-Shao, to whom Capt. A. E. J. Cavendish, author of one of the latest books of travel, had a letter of introduction from Ming-Yuen-Ik, his exiled brother at Hong-Kong.—Illustrated London News.

THE COREAN MINISTER OF FOREIGN AFFAIRS.

MALE AND FEMALE ATTIRE IN VARIOUS NATIONS AND AGES.

A VERY able and interesting article on this subject appears in the August number of the Arena from the pen of Ellen Battelle Dietrick. The article is handsomely illustrated with engravings of the costumes referred to as pertaining to the different periods mentioned. We present a few abstracts.

Man did not invent, nor did he first wear, that bifurcated garment which is variously designated as "trousers," "breeches" or "pantaloons." The fact is that trousers were a purely feminine invention, created by woman for her own special wearing, and man was actually reproached by his contemporaries for copying feminine fashions when he first began to adopt trousers for his attire!

The earliest allusion to this garment is by a historian who lived in Greece about 450 B. C. He is describing the costume of various troops, of the Caspians, who wore "goat-skin mantles," of the Thracians, the Cilicians and numerous other races, clothed in tunics and half boots, but the Persians, he tells us, "wore on their legs loose trousers," and "the Medes marched equipped in the same manner as the Persians, for the above is a Medic and not a Persian costume." Now another Greek historian supplies a missing link by the information that this peculiarly feminine fashion which the Persians copied from the Medes was the invention of Queen Medea, who gave her name to, and ruled over, that portion of the human race known to us as the Medes. Says this Greek historian, Strabo, "Trousers are proper to be worn in cold and northerly places, such as those in Media, but they are not by any means adapted to inhabitants of the South;" but he adds that after the Persians conquered the Medes, "The custom, however, of the vanquished appeared to the conquerors to be so noble, and appropriate to royal state, that, instead of nakedness or scanty clothing, they endured the use of the feminine garment, and were entirely covered to the feet." But it is not alone in "cold and northerly places" that women invented trousers for their outdoor apparel. The first white men who visited Senegambia, as early as the sixteenth century, found the beautiful Fellatah women wearing short, close fitting trousers as an equally appropriate costume for the tropics, and the same fashion abides to this day in Morocco, Algiers and Tunis.

Since it is thus established that the bifurcated garment was a feminine invention for female attire, woman, in returning to "divided skirts" or "oriental trousers," will merely return to a perfectly womanly, eminently sensible fashion of her own original creation.

For thousands of years man wore skirts; scanty skirts, full skirts, plaited skirts, long skirts or short skirts, whether fighting, trading, preaching or manufacturing, precisely as woman does now (for she is still engaged in all these occupations in some parts of the world). Man has worn single gowns, double gowns, gowns trailing in the dust in true street sweeper fashion, apparently without thought of impropriety in such imitation of female attire; and woman has never interfered with this sincerest form of flattery, as far as has been discovered. He has copied woman's puffed sleeves, her slashed sleeves, her two yards long "angel" sleeves, her short sleeves above the elbow. He has worn rings on his manly fingers and, if not exactly bells on his manly toes, fringes of tinkling bells on his elaborately embroidered gown, necklaces around his manly throat, rings in his manly ears, adornments of jewels, flowers, feathers in his ringleted manly hair, and ribbons, ruffles, laces and precious stones wherever these could be added to his bedizenment.

In 220 A. D., Father Tertullian explains that he does not think men should wear their gowns long enough to trail in the dust, as is the fashion of many third century Roman gentlemen, but he vehemently reprobates all thought of abandoning this manly garment for the "effeminate" bifurcated garment imported from Persia. To-day Father Goldwin Smith does not care what women wear so long as they stick to gowns and eschew the erstwhile effeminate trousers, because, "after all, nature has made two sexes!" (We never know how amusingly absurd man can be until he gets to writing about the intentions of nature concerning woman.)

When the Jews living in Palestine had forgotten about their long haired distant relative, Absalom, they wrote much about short hair for men and long hair for women as a natural peculiarity, asking, "Doth not even nature itself teach you, that if man have long hair it is a shame unto him? But if a woman have long hair, it is a glory to her." Long hair, however, was not peculiar to the men of ancient Israel alone. The manly Assyrians allowed their curled tresses to flow down on their masculine shoulders with artificially careless grace; and the manly Athenians coiled their long locks on their masculine heads, in a knot fastened with golden grasshoppers. As we all know, the manly Chinese continue to wear their yard or two of braids neatly wound round and round their manly occiput.

Veil-wearing men are earliest referred to in the Homeric poems.

In the deserts of Africa and Arabia all men constantly wear veils even to this day, probably as a shield from the glare of the sun and the driving sand. Sometimes these manly veils are fashioned precisely like our country girl's sun bonnet; sometimes they are in one long strip wound round the manly head, crossed at one side of the manly neck, the ends hanging down the manly breast and over the manly shoulder. The noble Roman wore his veil in somewhat similar style. In Christendom the manly veil was first transformed into a hood with a huge rosette on one side and long flying streamers, then into a band round the chin and over the head, and finally it vanished by imperceptible changes.

Down to the fourteenth century there was almost no

distinction between the dress of English men and women of rank, save that when riding to battle men wore short skirts instead of long ones, covering their legs with long hose or with bandages. The Englishman's first bifurcated garment appeared about the twelfth century and was very full, like that of the Oriental women, but, unlike theirs, was extremely short, reaching only half way down to his knees; gradually it grew longer, until in the seventeenth century it had descended just below the knee, where it was tied and decorated with flying knots of ribbon and deep, full ruffles of lace. So recently as the sixteenth century, however, we find Christian philosophers still rebelling against the effeminate trousers, or breeches, as particularly unsuitable for men.

But, undoubtedly, man's ultimate rejection of the gown and adoption of the effeminate Oriental trousers (after discarding their unnecessary fullness) was due to a survival of the fittest in costume. Experience proved this bifurcated garment to be the perfection of sensible clothing for outdoor wear, adapting itself, as it easily may, to every sort of active business or pleasure, and this is, undoubtedly, to become the costume again worn, in unison, both by the feminine sex, which originally invented it, and the masculine sex, which has now universally borrowed it, the variation being merely in color, fullness and material. Already women in Christendom are returning to this bifurcated feminine costume for bathing, gymnastic exercise and bicycle riding. In the Orient it has never gone out of fashion during tens of thousands of generations.

Imagine what a blessing such a costume would be (of course with proper foot and head covering) to the 500,000 women who toil as agricultural laborers in these United States; or to the 3,000,000 who travel daily through dust or storm to the task of earning their own livelihood in shops and factories; or to the millions of housewives who now work in and about their dwellings, painfully and senselessly incumbered with long and heavy skirts. Robes, really, belong to the perfectly idle rich whose duties are performed by servants, or to the poor only as a purely indoor holiday costume. The student of a university, or the clergyman in a pulpit, may with propriety continue to wear long and flowing gowns as at present; but the artisan, the merchant, the soldier, throughout the whole world, have now pretty generally discarded gowns when bent on business purposes—only the smock frock of an English peasant, the short danseuse-like petticoat of the Greek soldier, or the plaited plaid skirt of the Highlander, surviving to remind us of the bygone days when all adult men wore this style of female attire.

A human being should cultivate absolute indifference to public opinion in dress, every one wearing what suits his or her purse, taste and occupation. The greater the freedom, the greater will be the variety of experiments in costume, and the greater these, the sooner shall we arrive at the ideal human costume. There are many reasons why it would be well that the street dress of men and women should be identical. On the streets they should be citizens, on one plane of equality, and the less there is in garb to indicate sex the better, as dress would then often be a woman's best protector.

Most, if not all, of the present physical inferiority of woman to man is a pure product of her present weakening costume. On a stormy day, she is a spectacle for mingled tears and laughter—tears for her stupid clinging to senseless fashion; laughter for her ludicrous unfitness for locomotion. Hair blowing about; a hat which has no reference to the shape of her head, piled with ornaments fit only for twelfth century Englishmen or nineteenth century American male savages; impeding skirts, now wrapping themselves round her struggling limbs, now flapping themselves miserably wet around her ankles, now clutched up in one hand, while the other hand strives to hold purse, packages and umbrella; the whole costume generally of frail, unserviceable material. As we reflect upon the amount of time, thought and money worse than wasted in such clothing of woman, we may well doubt whether Christian civilization has thus far given her anything in costume to be thankful for.

Were women arrayed in clothes requiring no thought whatever when they were once donned, in fabrics suitable to all sorts of weather, with hats fitting their heads and shading their eyes, and with some twenty or thirty pockets to dispose of personal belongings, we should hear very little about the need of helping them on and off street cars, giving them seats to which they are not entitled in public places, and treating them generally like beings of a physically inferior order. The single fact that wherever men and women are found little cumbered by clothing, there women display ability to work even harder and more steadily than men, is sufficient to prove that the weakness of women in Christendom is purely artificial; though, of course, their indoor life is as great a factor in their present degeneration as their unnatural costume.

More outdoor life, in sensible clothing, is to-day the chief need for woman in all modern civilizations. Hence her greatest benefactors are those who, instead of discouraging her by incorrect representations of what is womanly, will stimulate her to courageous use both of bifurcated garments and bicycles, welcoming, instead of forbidding, the divided skirt for every form of outdoor exercise.

Our author might have referred to the dangers of women's apparel. We will cite but a single example, quoted from the New York Sun:

Pittsburg, Pa., Aug. 22.—Last evening, while Miss Edith Clark, aged 17 years, with another girl, was standing near the Pittsburg, Fort Wayne and Chicago tracks at Clifton station, sparks from a passing locomotive ignited Miss Clark's clothing, and in a moment she was enveloped in flames. Frantic with fright and pain, she ran up and down. Miss Clark's companion finally succeeded in dragging her friend down an embankment and pushed her into the river, where she held her until assistance arrived. Miss Clark was terribly burned and may not recover.

DEATH OF BRUGSCH PASHA.

THE celebrated Egyptologist and philologist, Heinrich Karl Brugsch, usually known as Brugsch Pasha, died in Berlin September 10. He was born on February 18, 1827, in the city of Berlin. Even before he had left the gymnasium he showed his great interest in archæological studies by writing a Latin treatise on the Demotic writing. The early essays of Brugsch attracted the attention of Alexander von Humboldt and King Friedrich Wilhelm, who enabled him to finish his studies in Berlin. The king also defrayed his expenses on his first Egyptian trip in 1853. When Brugsch returned in 1854 he was appointed privat-docent in the Egyptological Museum in Berlin. In 1857 he made another trip to Egypt and in 1860 became the historiographer of the Prussian embassy to Persia. In 1864 Brugsch started a periodical devoted to Egyptian archæology. He held various positions in the diplomatic service of Prussia and in 1868 he became Professor of Oriental Languages in the University of Gottingen. In 1869 the Khedive of Egypt made him director of the magnificent collection at Boulak, the title of bey was conferred on him and subsequently the greater title of pasha. Since 1886 he has lectured on Egyptology at the University in Berlin.

The greatest work of Professor Brugsch was his "Demotic and Hieroglyphic Dictionary." His "Demotic Grammar;" "Religion and Mythology of the Ancient Egyptians;" "Materials for the Reconstruction of the Calendar of the Ancient Egyptians;" are among his other works. The death of Professor Brugsch will be regretted by scholars all over the world, as he stood in the very front rank among them, both as an Egyptologist and philologist.

THE MAORI KING.

TAWHIAO, who has just died of influenza, could only by courtesy be called the Maori king. He had no territorial possessions in his own right. But he claimed, and after a fashion exercised, a sovereignty over the native tribes in the Northern Island. The land on which they live was confiscated by the government upon the suppression of the Waikato war of 1865, and the restoration of this territory the king and his tribe demanded. It was for the purpose of furthering this

TAWHIAO, KING OF THE MAORIS.
Sketched from life during his visit to England in 1884.

object that Tawhiao, in 1879, came out of the seclusion in which he lived and had an interview with the Minister of Native Affairs at Auckland. Offers were then made to him that he should abdicate his kingship in exchange for a pension of £400 a year, a seat in the Legislative Council, and magisterial honors. These offers, however, he refused, and in 1884 he came to England, hoping to obtain from Her Majesty in person the favors which the colonial authorities had refused to grant. After his return from his Auckland visit in 1881, Tawhiao became unfortunately addicted to drink; but before setting out on his visit to England, Sir George Grey persuaded him to don the blue ribbon. His mission to England was a failure; the Colonial Office declined to interfere in the matter, and he was unable to obtain an audience of the Queen. The king returned to New Zealand much chagrined and greatly annoyed, but in 1892 he surrendered all further pretensions, and accepted an annual pension of £225.

Tawhiao was the son of Potatau, the first king of the Maoris—in his day a redoubtable warrior. Unlike his father, Tawhiao possessed no military instinct, and during the Waikato war was anxious to make peace with the Europeans, but was overruled by the more turbulent chieftains. He was a man of middle height, fairly robust, and with a face deeply scarred with tattoo marks—heraldic signs which traced his ancestry back to the arrival of the first Maoris from Hawaiki. Almost his only ornament was his shark's tooth, suspended from his ear by a black ribbon. During his visit to England, in 1884, he permitted an artist of the Graphic to make a sketch of him from life. While the sketch was being made the king wore a white flannel coat; but he changed this before dinner (to which he invited the artist) for a black jacket, with buttons fastening up the back. He was fond of wearing a gray chimney pot hat, and the combination of this with a pair of spectacles and a pipe (for he was as devoted a smoker as Prince Bismarck) was exceedingly droll.—Daily Graphic, London.

[THE TECHNIC.]

A FEW WORDS FROM A LANDSCAPE GARDENER.

LANDSCAPE gardening has for its object the preservation and development of outdoor beauty. I am glad of this opportunity to make a plea to engineers for the preservation of pleasing features in our landscape, because engineers and surveyors may exert so much influence in this direction. An enumeration of a few cases where unnecessary damage has been done will serve to introduce the subject. A piece of land was purchased for its fine trees, a rapid stream of water that flowed through it, and its proximity to Lake Michigan. A surveyor was engaged to determine the boundary of the tract. One of the lines which he ran for this purpose happened to pass through an old red cedar, which the axman did not hesitate to mutilate by cutting off half the branches. The tree had stood by itself and was exceptionally perfect. If its value as an ornamental tree could be given in dollars and cents (but this is a poor way of estimating the value of such a tree), it would be placed at from fifty to one hundred dollars. Cutting the tree saved perhaps half an hour's time for the surveyor.

A few years since, in visiting a suburb of Chicago, which was fortunate enough to have a native forest growth, I was pleased to see that some of the original trees had been left along the roadside. An old oak with a thornapple tree that stood near made a delightful group. There were also maples, lindens and hickories. When I saw this street a year or two later it had been improved(?) Its grade had been changed slightly and the fine old trees, in picturesque groups, were removed to make room for straight rows of little elms.

In one of the older cities in New York maples, elms and other trees were planted at an early day. They were placed from fifteen to twenty feet apart in rows on each side of the street. In a few years they crowded each other and shut out light and air from the houses; so the lower branches were cut off, and this process of trimming went on until in many cases the naked trunks, with ugly scars, where the branches had been removed, reached above the second story windows. The upper branches spread across the street and over the houses, completely shading everything but the back yards.

In the outskirts of another city in New York lived a man whose grounds along the street boundary were fringed with native dogwoods, sumachs, Juneberries, witch hazel and sassafras, with here and there a wild grape or virgin's bower. In certain nooks goldenrods and wild asters found homes, so that this group of native growth formed as interesting a collection of foliage and flowers as could be found along the highways for miles. But one day the fever for improvement seized the owner of the land and he had all the "brush" grubbed out. He then hailed a passing acquaintance who, he knew, had some skill and good taste in planting, informing him that he wished to plant some shrubs and would like his assistance in selecting and arranging them. The man of taste replied that it would take ten years to produce an effect of shrubbery as good as that which had just been destroyed.

I mention trees and shrubs first, because they are the materials with which a landscape gardener works—his paints. There are, however, other features over which the engineer has entire control—features which have much to do with the appearance and comfort of our surroundings, and hence come within range of the landscape gardener's criticism. These are grades, location of catch basins, sidewalks, curbing and frequently the location of the street itself. How often do we see profiles made with straight lines, frequently perfectly level, when a slight curve would save expense, keep the roadbed drier, and improve the appearance of the street. Catch basins for receiving the surface water are very generally placed at street intersections, making unnecessary steps at crossings and often obstructing these crossings with water during heavy rains. There will seldom be any difficulty in placing catch basins at some distance from corners, thus keeping the passageway for those on foot high and dry. Again, sidewalks are usually made to follow the grade of the roadway, when there is no real reason why they should do so, excepting the desire of the engineer to simplify his own work. In residence districts streets are usually sixty-six feet wide, thus leaving a space of six to ten feet in width for grass and trees between the roadbed and the sidewalk. Where entrance drives to private grounds are not desired, no harm comes from leaving the sidewalk one, two, or even three feet above the street grade. Such an arrangement would frequently save fine old trees and also the expense of regrading and planting residence grounds. The steeper slopes could be covered with hardy shrubs, which would give a pleasingly varied and homelike effect.

In one of the most desirable residence districts of Chicago the streets are nearly all macadamized. Stone curbing separates the macadam from the grass plat. I have just measured this curbing in many places, and find it to project from six to fourteen inches above the adjacent surface of the roadway. In such localities, where driveways are constructed of gravel, broken stone or asphalt, curbstones are not only expensive and unsightly, but worse than useless. They are especially dangerous when horses become frightened and shy to one side or run away. They prevent rainwater and melting snow from running off from the road surface and soaking into the ground on each side, to the great benefit of trees and grass. With a brick or wooden pavement the curbing is necessary, but it should be kept low, a projection of two inches above the adjacent surface being sufficient.

Having, perhaps, spent enough time in criticism, let us consider what can be done to make a street attractive. We will assume that a pleasing variation in grade and proper drainage have been secured, and that, while the grade is an easy one, it has been placed so low as to do the least damage and be of the greatest benefit to the property on each side. It is nearly always desirable to have residence lots somewhat higher than the street. The appearance is also improved by hav-

ing the houses placed some distance back from the lot line. While it is by no means essential that all houses should be placed the same distance from the street line, it is a wise measure to have a line established in front of which no building can be erected. Houses can sometimes be built at various distances back of this line with good effect. When the grade is properly taken care of and the houses correctly placed, the planting can be commenced. Care should be taken not to plant in such a way as to keep sunlight out of the windows, and some open spaces along the street give to it a better appearance than it would have in continuous shade. The planting of shrubs and vines about verandas and along the blank walls of buildings will help to make them attractive and homelike, but this is a matter for individual taste. The street planting ought to be designed with a view to its effect as a whole. The United States is wonderfully rich in its variety of trees and shrubs, very few of which are unattractive or objectionable. A walk of a mile or two along a suburban or village street ought to show all the variety of tree growth, shrubbery and hardy herbaceous plants that can be found in the surrounding country or in the best parks, exclusive of their greenhouse and aquatic plants. The upper outline of the planting should drop here and there, showing an expanse of clouds or sky, a beautiful house or attractive grounds. This variation can be made by using for the taller trees, elms, maples, oaks, beeches, lindens, tulip trees, honey locusts and many others. These should be placed in irregular groups, such an arrangement being far more pleasing than straight rows, and the only arrangement which would admit of the selection of different species. Trees placed in a row should be of one kind, at least for one block, as nearly alike as possible. For a smaller growth use Juneberry, sassafras, red bud, the larger dogwoods, the various thorns, blue beech, ironwood, etc. These are all beautiful trees and will often shade a sidewalk while allowing the sunshine to reach the house. Then I would urge the use of a still smaller growth, such as witch hazel, sumacs, including rhus aromatica, the smaller sized dogwoods with red bark, barberries, Japan quince, buckthorns, syringas, sweet brier, etc. These will hide, to some extent, the naked trunks of trees and give a soft, varied outline to a street view. They separate the sidewalk from the driveway, giving an agreeable seclusion. They help to make a beautiful and interesting walk from the railway station or office to our homes at all seasons of the year—in spring and summer, with the variety and freshness of their foliage and flowers, which are placed where they are most easily seen; in autumn, with their foliage and fruits; and in winter, with the soft colors and fine spray of their branches. Finally, I would recommend the use of hardy perennial herbaceous plants—snowdrops, crocuses, hepaticas, trilliums, lupines, goldenrods, wild sunflowers, asters, etc. It will be said, of course, that these flowers, as well as those of the shrubs, will be picked and the plants destroyed. The same objection was urged in regard to flowers in public parks, before these parks came into existence, and proved that such fears were for the most part groundless. To learn to enjoy a flower without picking it and to see or hear a bird without wishing to throw a stone at it, should be a part of every child's education—yes; and of every grown person's too. At more or less rare intervals we go miles to enjoy the beauties of a park, and this is quite right and justifiable. But how much enjoyment would be added to our lives if we could have these beauties distributed along the streets that lead to our dwelling places, where we would see them every day; and not to our lives only, but to those of strangers and visitors, who, after seeing how attractive a public thoroughfare might be made, would perhaps imitate the example in their own neighborhood.

The general public has not yet learned to appreciate what a very useful person a landscape gardener is. They fail to recognize the fact that by following his suggestions they save money, enhance the value of their property, and, what is of more importance, add to the pleasure of living. The landscape gardener's name does not appear on the city pay rolls, but the engineer has a hold on the public, and so I appeal to him to give more thought to the artistic side of his profession. If there are natural variations of surface, running brooks, ledges of rock, fine old trees, groups of shrubs, or any other features of natural beauty, let the engineer study out a way to preserve them, without in any degree lessening the usefulness of his own work.

I believe there is at the present time a tendency toward greater appreciation and love of art. Let me close this paper with the hope that all who read it will try to help forward this movement and give special attention to "art out of doors." O. C. Simonds.

THE GINKGO.

The tree of which it is a question in this article is not unknown to our readers. The Marquis de Saporta has discussed it at length and with the competency that this learned academician brings into all his work. But it is principally from the view point of paleontology that the ginkgo is regarded in this study, although Mr. De Saporta tried to neglect nothing of the history of the modern tree.

The object of this article, which is much more modest, is to encourage lovers of beautiful plants to extend the culture of this tree of original aspect and of indisputable decorative effect.

The ginkgo was discovered in Japan in 1690 by the traveler Koempfer. The oldest specimen known in Europe is that of the botanical garden of Utrecht, planted, it is said, in 1727. Forty years later it was introduced into England, and finally the Museum of Paris obtained it in 1780.

There are few exotic plants that have so easily adapted themselves to our European climate as this.

The ginkgo is sometimes called by the name of "Arbre aux Quarante Ecus." It is to the dearness of the individuals that long existed in commerce that this name is attributed; but the following anecdote, which is worthy of being related, seems to be the most correct version of its origin.

Andre tells us that a Parisian amateur named Petigny went to London in 1780 in order to visit the gardens of England. At an English merchant's he found five ginkgo plants growing in the same pot. After a hearty dinner, to which the Englishman did too much justice, Petigny purchased from him for twenty-five guineas the pot that previously was not for sale. The next day the English horticulturist offered Petigny in vain twenty-five guineas for a single plant. The price of the five ginkgos therefore came to 120 francs, or 40 ecus, and thus the tree got the name that it now bears.

Those who are inexperienced in botany are always surprised when they are informed that the ginkgo belongs to the great family of Coniferæ, tribe of Taxi-

Fig. 1.—LEAVES AND FRUIT OF THE GINKGO.

nese, a place that was assigned to it by Smith in 1797, after an attentive study of its reproductive organs. It is certainly a tree that in aspect seems little allied thereto, for it sheds its fan-shaped leaves every year like the larch and the bald cypress, and, when it fruits, becomes loaded with fleshy drupes full of a resinous juice of a detestable flavor. The seeds alone are edible, and these, boiled or roasted, are consumed in China and Japan, where the tree is met with planted by preference near temples or tombs. The tree is not known in a wild state; there seems to be no doubt about that, and this is the interesting scientific point about the plant. It is the sole representative of an extinct genus which was formerly widely distributed in the northern hemisphere in the cretaceous epoch.

Paleontologists have found the ginkgo in a fossil state along the east coast of Greenland and as far as to the river Amoor; then in Central Europe, in Hanover and England; and finally in Spitzbergen and Siberia. It has been found even in the southern hemisphere, and an antarctic species has been collected in Australia, but always of the secondary period. A dozen fossil species of ginkgo are known, differing from one another in the more or less deep division of the leaves, or the size of them.

Thus we have here a plant whose ancestors were widely distributed over the earth and which remains the sole one of its family. Mr. De Saporta says with much justice that it would doubtless long ago have disappeared if the singularity of the tree, its relative beauty, and the nobleness of its aspect had not caused to be attached to its presence a sort of religious prestige, which in China, as in Japan, has led the natives to plant it around their temples.

One of the causes, not enough remarked, perhaps, of the extinction of certain plants, is their uni sexuality. As the ginkgo is monoecious, it is impossible to count upon the perpetuation of the species when we have but one of its sexes. The yew, a close ally of the ginkgo, which is in the same situation, and which is not cultivated like a forest tree, will doubtless disappear more than any other species that bears both male and female flowers upon the same plant.

The name ginkgo [which is really the name of the fruit, and means "silver almond"], under which Koempfer mentions this tree [and which is due to a misprint in his Amœnitates Exoticæ, the name as heard in Japan being ginkiyoo], has for synonyms the names ginan and itsjo in the extreme East. When Smith published the characters of the ginkgo in detail at the end of the last century, he thought it his duty to change the name given by Koempfer, as being barbarous and inaccurate, and imposed upon it that of Salisburia. Botanists after this had their choice between Ginkgo biloba or Salisburia adiantifolia for designating this tree. Whatever be the reasons given, it is always regrettable to see synonymy increase in science, and nomenclature become encumbered. This name Salisburia prevailed with many, and the paleontologists have taken the term Salisburieæ as a name for the group of different fossil species of ginkgo.

We have said above that since the ginkgo is monoecious it is impossible for a single plant, although female, to produce seeds. At the time of its first introduction into Europe, there were no two plants of the species in proximity with each other and of different sex, and, the tree being very rare, those public establishments or privileged individuals who possessed a single specimen were fortunate. As the seeds capable of germinating came from China or Japan, one could boast but little of obtaining any. An endeavor was therefore made, and successfully, to propagate the plant by cuttings or layers, and for a long time this was the only method of multiplication. When De Candolle, who was at Montpellier, where there was a male plant of this tree, discovered at Bourdigny in Switzerland a female ginkgo, he obtained a branch of it and had it grafted upon a limb of the Montpellier specimen. A short time afterward this bore fruit. This horticultural event was disseminated through the press, and grafts from the fruit-bearing plant of Montpellier were soon requested of De Candolle from Milan and then from the garden of the King of Italy, wherein there were some male ginkgos. A few years after this grafting the Milan tree produced its first fruit. The gardener who took care of it made a profit out of it for a certain time without any one being aware of it. He sold his seeds clandestinely, and, it appears, received a high price for them. People came to admire his tree, whose fructification was an interesting curiosity, but he took care not to make known the profit that he was deriving from it.

When the gardener died, one was surprised to receive several letters requesting the delivery of ginkgo seeds as usual. As may be supposed, the new gardener was not authorized to devote himself personally to this trade. Yet the tree continued to fruit still more profusely, and the orders did not cease to flow in. When the stratagem became known, it was explained how for several years certain seedsmen of Germany had announced in their catalogues ginkgo seeds that they alone possessed. These came from the Mi-

Fig. 2.—THE GINKGO OF THE GARDEN OF PLANTS, AT PARIS.

lan tree and from another situated in a village near Mozzo, in Italy.

The seeds, as may be seen, easily become fertile in Europe, even in the relatively cold latitude of Paris. However, it is well before sowing them to make sure of their germinative quality by immersing them in water. Those that float upon the surface are generally bad.

The multiplication of the ginkgo is therefore a very easy matter, through slips or layers or seeds, which are now of a reasonable price. This tree grows in all soils, although we read in one place that it requires firm and humid earth, and elsewhere that it demands a sandy and light soil. I know of some under the worst conditions that maintain themselves, after a manner, and, what is remarkable, have resisted the severe winters that we have had in France for twenty years past.

The few specimens of the tree of the Paris Museum are not planted in favorable soil. The earth of this garden is exhausted, and a number of trees and herbaceous plants that were remarked there have disappeared during the last half century. Yet the tree represented in Fig. 2, although but five feet in circumference at three feet above the surface and thirty-five years of age, is one of the most beautiful that we know of in the form and elegance of its branching.

HABENARIA SUSANNÆ—FLOWERS SNOW-WHITE.

Before such a tree we see at once that it in nowise resembles what we daily observe; it has truly something of the Chinese or Japanese in its aspect. So, in a park, it is immediately distinguished from its neighbors, and it seems to us to be as indispensable upon a lawn or in a clump of trees as the graceful birch. Its growth is moderate, but continuous, and its trunk rarely reaches large dimensions. Yet Bunge observed a very old one in the vicinity of Pekin that was nearly forty feet in girth and proportionately tall.

From the standpoint of utility we can mention only the use of the edible seeds, boiled or roasted. No particular use seems to be made of the wood of the tree, and yet it ought to have relatively useful qualities. It is somewhat hard, of a pretty yellowish white color, fine-grained, homogeneous and easily worked; and, finally, it is not resinous. However, as a beautiful ornamental tree, it may be claimed for it that it possesses qualities of the first order, and that it sums up the utile dulci of Horace—that is to say, perfection.—La Nature.

ONE of the latest uses to which paper has been put is the making of telegraph poles. The paper pulp employed is saturated with a mixture of borax, tallow and other substances. The mass is cast in a mould with a core in the center, forming a hollow rod. The cross-pieces are fastened to the pole by wooden keys.

HABENARIA SUSANNÆ.

WITH the introduction of the Malayan species, a fresh impetus has been given to the culture of these terrestrial orchids in gardens. The first of the warm-house species to come in any quantity was H. militaris, that beautiful cinnabar scarlet, which species is now so well managed in many gardens, but which proved restive at the onset.

Then came the pretty flesh colored H. carnea, and more recently H. c. nivosa, the white form of it. All these have variously colored leaves, and are highly ornamental even when not in flower.

The last novelty, H. Susannæ, a pure white species, for which Messrs. F. Sander & Co., St. Albans, received a first class certificate at the Royal Horticultural Society's meeting of the Orchid Committee, August 28, is a tall habited plant, with plain green leaves, and, like the other species named, it does not seem difficult to grow, if placed in a light position in a tolerably warm and moist house.

After flowering, the leaves of all these habenarias fade, and the supply of water should be gradually lessened. When they are quite at rest, they should be placed in their pots on a dry shelf, only a little water being given to them at long intervals. When they are about to start into growth again they should be repotted into tolerably small pots, crocked one-third the way up, the lower part of each tuber being rested on the crocks before the compost of fine sphagnum moss, peat, crock dust and loam fiber is placed round them, the growing point being kept just below the surface. Soon after potting they should be liberally watered until flowering is over.—The Gardeners' Chronicle.

DEVELOPMENT OF MINERALOGY—IV.*

By L. P. GRATACAP.

THE name of Steno is associated with the promulgation of a principle in crystallography which laid the foundations of the science upon a fixed law and brought into scientific unity a wide series of apparently discrepant mineral aspects. Steno determined the angular invariability of natural crystals, viz., that, however distorted or modified, the faces of crystals made with each other the same angle under all abnormal or disturbing relations. Bartholin, Janitzer, Huygens, Boyle, had contributed important observations both on crystalline measurements and their physical constants; Huygens had speculated in a very modern fashion on the ultimate molecular constitution of minerals and Boyle hastened the determination of the specific gravity of minerals; Janitzer and Bartholin had both made crystals and measured them, but Steno threw a new light on the subject when he affirmed that under all conditions crystals maintained a fixed crystalline unity. It was an affirmation which brought order out of confusion and sensibly led the way to the later determinations of crystallographic constancy which created a new science, of which Rome de l'Isle, Hauy, Bergmann and Werner were the pioneers.

Steno was born in 1638, at Copenhagen, and died in 1687, at Schwerin. His life was devoted to study, and he ventured upon theological disputes with the same ardor with which he attacked mineralogical problems. He insisted upon the growth of crystals from the outside by the addition of material derived from a fluid in which they might be immersed, not from some vegetative power of increase; he observed the unequal enlargement of crystals, their obliquity, and in the case of quartz explained the striated prismatic faces as due to the oscillation of the terminal (pyramidal) faces with the side (prismatic) faces. He made out the fixed angular relations of the faces of crystals, and in his speculations upon the cause of mineral increase assigned the latter to the effects of magnetic attraction. Steno was followed by his contemporary Gulielmini, an Italian, who corroborated the fixity of the crystalline angles, noted the restriction of one kind of crystallization to different species, as cubes to salt, octahedrons to alum, emphasized the fact that a crystal is made up, no matter how large, of innumerable similar smaller crystals, that these, fitting together, leave openings which give porosity to the crystal or contain water which may be expelled by heat. His observations went a great way to extricate the subject from the opprobrium of mere speculation, and mineralogy, on its physical side, at least, was beginning to assume, more and more, the outlines of a great science. Keener students were constantly publishing their conclusions, descriptive mineralogy grew when Schenebeger described in great detail the variations of quartz, when Cappeller enumerated the structural types of mineral occurrences as spherical, conical, wedge-shaped, fibrous, micaceous, lenticular, when Bourguet definitely cast aside the idle, childish notions as to the origin of minerals from seeds and germs and separated fossils proper from minerals; stalactites were no longer regarded as vegetable growths and the various efflorescences of salts were put into the category of mineral products. Light was breaking over the subject of mineralogy in every direction, and the opening of the seventeenth century found a vast number of observations and inferences and some principles recorded. The crystalline systems were not yet suspected, the range of material studied was narrow, being the artificial salts, and precious stones, quartz and garnet, calcite, gypsum, and the more obvious metallic minerals, and mineral chemistry was struggling in imperfect ways to bring about a classification in minerals, an attempt which was necessarily hopeless until at the end of the eighteenth century the methods of analysis were created by Berzelius.

There was, indeed, chemical mineralogy, and Boyle, Becher, Stahl—the distinguished author of the Phlogiston theory—Henkel and Pott, had contributed to bringing processes of chemical analysis into use for determining minerals. The remnants of a mythical age, however, still clung to the science. The sun was regarded as typical of gold, carbuncles, chrysolite, hyacinth; the moon, of alum, marcasite, white and green minerals; to Saturn were referred lead, copper, arsenic, sapphire, magnetite; to Mars, the red and sulphurous species; and to Venus, beryl, lapis-lazuli, emerald and silver. A rude and purely superstitious use of minerals, powdered and introduced into water, was practiced for medical purposes. The discerning Henkel wrote about the metals as if they possessed animate affections, and assigned to them a certain moral order, while their peculiar affinities and unions yet affected the students with those impressions, derived from the alchemists, of love and friendship. All this was inevitable; science was passing from the subjective to the objective stage. The custom of interpreting the motions of matter by the affections of the mind yet retained its hold in language and conceptions. All was vague, and, as it has been said, many scientific writers of the time were happy in being ignorant of their own ignorance.

Henkel and Pott, in the period lapsing from the seventeenth to the eighteenth century, were perhaps most active, and their chemical researches helped sensibly to introduce more exact definitions of mineral species. Heat at various intensities was a common agent for chemical investigation. In this way the combined water of gypsum was detected; Boyle had subjected gems to the ordeal of the furnace, and averred that from most of the transparent minerals he had obtained a pungent vapor. Henkel divided stones or minerals into four classes, according to their behavior when exposed to heat: as they (1) withstood fire; (2) as they were hardened by fire; (3) as they underwent pulverization upon rubbing after heating; (4) as they melted in fire. In the first class he arranged the diamond, ruby, beryl, sapphire, topaz, chrysolite and silica; in the second, clay, serpentine, fuller's earth and other clays; in the third, limestone, alabaster, sinter; in the fourth, sulphur, garnet, Oriental hyacinth, malachite and Icelandic agate, viz., obsidian.

The fundamental constituents of stones were argillaceous substances, calcareous or metallic, and subsidiary to these, the salty, oleaginous, metallic and saline-sulphurous. These distinctions were far removed from that definiteness of chemical composition which characterizes mineralogy, but still they contained a rude approximation of a general scheme not altogether irrelevant to the facts of nature. In the realm of metals the species were perhaps more numerously separated, and the more common sulphides were recognized. But no means then existed for invading the unexplored regions of mineral production and bringing to view new species, assigning them their categorical position and giving them individuality. Pott followed Henkel, and along the same lines of chemical investigation strove to delimit the relations of minerals. He divided minerals into four classes:

1. The alkaline and calcareous.
2. The gypsiferous.
3. The argillaceous.
4. The vitrescible.

In the first he placed the limestones, carbonates and

* Continued from SUPPLEMENT 968, page 15518.

calcite; in the second, gypsum; in the third, the clays and allied earths, which hardened in fire; and in the fourth, those silicates which fused in fire either alone or upon the addition of some flux, and in which were embraced the silicates, fluorides and many gems. Pott separated alabaster from limestone, a confusion that had long existed; he noted the phosphorescence of minerals, struggled with the definition of talc, serpentine and the clays, and studied reactions. Terms which have a specific, irreplaceable application were then applied most equivocally. The term marcasite was used in connection with rock crystal by miners; by alchemists it was applied to "undeveloped" metals. Marcasita ferri was silica; marcasita cupris, a yellow or greenish yellow copper ore (chalcopyrite); marcasita aurea was a zinc, tinged yellow with copper; marcasita argentea was bismuth. The alkaline earths were not yet separated, the silicates unknown, zirconium and beryllium undiscovered, and the metals but partially individualized.

Schemes of nomenclature, systems were proposed by various authors. But as compared with those which have to-day reached so perfect a state, at least of specific definition, they seem very crude. The fundamental conceptions of chemical union were yet undeveloped, the list of elements approximate, and the methods of chemical analysis, as now understood, unknown. So that on all the grounds of observation attainable, the expectation of making a permanent system was hopeless. A number of students at the end of the eighteenth century began a revolution in mineralogy, aided by those advances in chemistry by which the constitution of compounds was elucidated. Among these Bergmann, Scheele, Kloproth, Bruckmann, Mayer, Gerhardt, Hoffman, and many others became distinguished. The science of chemistry was advancing toward a determinate condition. Priestley, Lavoisier, Scheele, Cavendish, Richter, Dalton, were introducing a knowledge of the nature of combustion, the theory of atomic unions, a clearer thought in chemical philosophy, and above all an appeal to the balance as the judge of chemical conclusions. Somewhat before this time the divine Linnaeus had inaugurated the momentous change in zoological and botanical nomenclature which has placed him in the highest rank of scientific benefactors. But Linnaeus also essayed the difficult task of putting in order the confused retinue of mineralogical facts, although as he said in his preface, he had deputed to others this subject, and, unless importuned (lacessitus), did he consider them. This system of Linnaeus has a double interest as standing somewhere between two periods in the history of the development of mineralogy, the period of the mediævalists and the moderns, as holding yet some of those semi-metaphysical notions which made up the mineralogy of speculation and as incorporating some of the facts and observations which laid down the foundations of the experimental science.

Linnaeus alludes with admiration to the labors of Woltersdorf, Wallerius, Cronstedt, Vogel, Just. Swab, "who, inspired with the divine breath, have given their observations to the learned world, to whom, since with infinite labor and exhaustion (sudore) they have penetrated the abyss of nature, and the depths of mountains, glory forever is due from all just judges." To the eye of Linnaeus the mineralogical world seemed a generative womb wherein through the conjunction of male and female elements the propagation of mineral species went on in a sort of inorganic accompaniment to the wide fecundity of organic nature. From the water, the omnipresent ocean, arose in the beginning everything, and this humid, cold, passive, conceiving water, fecundated by the dry, heating, active, generating air, brought forth two mineral principles, the masculine, sharp, clear, crystalline salts, and the feminine, fixed, viscid, opaque, cohesive earths. These salts, sapid, polyhedral, diaphanous, complex, decomposable (solubilia) into infinitely minute particles, nevertheless always alike, uniting together again and again into similar larger particles, generate by crystallizing in and from various earths, various stones.

These salts were nitrum, muria, natrum, alumen, and Linnaeus calls them the fathers (patres) of stones. Nitrum atmospheric or gaseous in nature was the mate of sand (arenam), silica, etc.; muria, marine in nature, the mate of clay (argilla), all argillaceous matter; natrum, animal in origin, united with lime (calcem), and alumen, vegetable in disposition, penetrated the ground (humus).

These four earths, argilla, arena, humus, and calx, were the mothers (matres) of stones.

Linnaeus added to this list of saline crystallizing elements borax, vitriolum, mirabile, amarum, all alkaline salts—vitriolum, a type of sulphates, including many metallic salts—whose obvious crystallization was so prevalent and whose crystallizing efficacy he invoked as in some way expressive of all other forms of crystallization. In his classification the earths (terræ) come first as a class, viz., those mineral matters in which argilla, arena, humus, and calx prevail. He divided them into the talcose, ponderous, calcareous, argillaceous, and siliceous. The talcose embraced talc, serpentine, asbestos, actinolite and hornblende; the ponderous, barite and crossopetra; the calcareous, chalk, tophus, calcite, lamellar calcite (schistospathum), inolite, stalcatite, pisalite, marble, foetid limestone (suillus), tremolite, stellaris, humus, marga, magnesite, gypsum, hepaticus, fluorite, apatite; the argillaceous, various clays with lava, mica, opal, zeolite, and schorl.

In the siliceous, Linnaeus put olivine, feldspar, petrosilex, jasper, emery, zircon, lydian stone, garnet, sand, quartz, chalcedony, corundum.

The salia or salts formed his second class, and these were natrum, carbonate of soda, borax, muria, common salt, nitrum, nitrate of potash, mirabile, sulphate of soda, amarum, Epsom salts, alumen alum, vitriolum or alkaline sulphates. To the crystalline form of these salts he wished to refer the crystalline forms of the minerals, and he regarded these salts as crystalline categories to which all crystals were to be referred. There was not, however, in his mind any suspicion of the six systems, geometrically individualized, which Hauy and his followers defined.

The class of combustibles followed the salts, and among these were bitumen, amber, graphite, and sulphur. Class fourth comprised the metals as then known, being uranium, wolfram, magnesium, antimony, zinc, molybdenum, tin, cobalt, iron, arsenic, copper, nickel, bismuth, silver, lead, mercury, gold, platinum.

He enumerated the known crystals under hexahedral, octohedral, decahedral, dodecahedral, fourteen, eighteen, twenty-four, twenty-six, thirty-six sided solids with rhombic, rhomboidal, rectangular, trapezoidal and scalene faces. The names given by Linnaeus were often generic in character, and what are now considered as distinct minerals were grouped under one designation. Thus under gemma we find ruby, sapphire topaz, hyacinth, spinel, aqua-marine, beryl, chrysoberyl, emerald, garnet, while again under quartzum a long list of varieties is given, all referable to quartz, but characterized by such peculiarities as to-day distinguish the examples of this omnipresent mineral as fibrous, pitted, eroded, cellular, lamellar, globular, cylindrical (?), granular, green, unctuous, tabular, rock crystal, etc. The book of Linnaeus upon minerals in the kingdom of nature was a systematic work, it marked the progress made in reducing the numerous observations of students to some sort of order, and gathered in a scientific fashion all of those observations and started out a practical check list. But the mineral kingdom was very poorly understood as yet, and the modern collector would wander hopelessly amid the pages of Linnaeus to recognize many of the more common occupants of the shelves of his cabinet. Linnaeus indeed was but partially acquainted with the chemical researches of his day, and his work is scarcely an adequate reflection of the researches of contemporaries. Woltersdorf, in the preface to his mineral system, wrote about this time: "The first and best distinctions to be followed in a classification of minerals must be based upon their constitution. As minerals neither live, nor grow, nor feel, they are not organic in nature, have no anatomy and sense apparatus, by which they can be distinguished. Therefore in this matter we should place no reliance on the exterior appearance. There are mineral species of one genus which in no way resemble each other. On the other hand there are found some of entirely separated classes which have the same form. We must therefore determine the relationship and the differences of minerals, according to their composition, or by the material of which they are made, and from these classes, orders and genera are fixed." Names were in great confusion, and no authority established a name when introduced, nor rejected it, so that each author had free play, and that liberty, in conjunction with misunderstanding of the nomenclatures previously used, added to the perplexity.

Garnets were known as carbuncles, anthrax, pyrope, amethystizonton, sistites, carchedonius, sandaresos, lychnites, jonis; chrysolite as leucochrysos and melichrysos; emerald as cholos, chalcosmaragdus, pseudosmaragdus, galactite, and so on. A desire for making systems was prevalent, and numerous writers ventilated their plans at a time when no rule or criterion was established to make any permanent. The latter years of the eighteenth century brought in new researches and mineralogical physics and chemistry began to co-ordinate in lines of true affinity the minerals that were known and to add to their lists minerals that were either new or had been disengaged from some previous synonomy.

GOLD GENESIS.

By HENRY WURTZ, Ph.D.

IN the SUPPLEMENT of September 8 last (p. 15587) there appears an article taken from Knowledge, and written by Prof. J. L. Lobley. The writer premises, in substance, that not more than one generation since (say 1864) the igneous origin of mineral veins generally was advocated by eminent geologists. This is true: Murchison, in "Siluria," David Forbes, and numerous others, maintained it. The history of this subject cannot be gone into. It entered into the chemi-geological controversies between Forbes and our own Sterry Hunt (now gone from us), about 1867. The gold of quartz veins, as Prof. Lobley says, is still held by many as of igneous origin. Others, admitting that the veins were deposited from solution, yet claim that the gold came from the "bowels of the earth."*

Prof. Lobley discusses largely the fact of the general total absence of gold from the products of volcanic action all over the earth; exhibiting a remarkable mastery of this subject. He refers to the theory of oceanic origin of gold as "recent." The readers of the SCIENTIFIC AMERICAN may be interested to learn that this theory is some thirty years old, and originated on this side of the Atlantic.

In an extended memoir, called "Gold Genesis," read by the writer, in 1866, to the American Association for the Advancement of Science, this oceanic gold theory was brought forward, and completely demonstrated, chemically and mineralogically. This memoir was also published in the American Journal of Mining (precursor of the present Engineering and Mining Journal), in Heatherington's Nova Scotia Mining Gazette, and probably elsewhere. Moreover, the original two chemical discoveries, which founded this theory, go back to 1858, having been also presented to the American Association in that year. No controversy of any consequence arose, as the demonstrations presented left but slender room therefor.

Subsequently, at the time of publication of Murchison's Siluria (about 1868), the present writer controverted all the views of Murchison as to the igneous origin of gold, presenting familiar facts wholly incompatible with them.†

After extensive exemplification of the fact that gold is always a product (or rather, educt) of non-volcanic rocks, Prof. L. proceeds to state his theory of the condition in which gold has been held in solution, in order to be introduced and deposited in veins, etc. In this he claims to be sustained by Bischof, Sterry Hunt ‡ and Newberry. This, as he states it, is that there exists an unknown silicate of gold, soluble in water, under heat and pressure.

Such silicate is assumed to have accompanied the metamorphism of the crystalline gold-bearing rocks. No such silicate is likely to be admitted now as probable by chemists. Of course it is the association of gold with quartz that has suggested this hypothesis. But the same argument may apply to all the heavy metals. Moreover, though gold, like other heavy metals, is abundantly associated with quartz as a vein stone, yet the commonest matrix of the precious metal is not quartz, but iron pyrites. This, in a genetic view, associates gold, not with silicon and oxygen, but with iron and sulphur. The fact that silica is an extremely prevalent vein stone associates it with all vein metals. The pressure, motion and heat that produced metamorphism (as also pointed out first by the present writer in "Gold Genesis" in 1866; see Dana's Geology, 1880, p. 762) are now universally recognized as the conditions that led to the aqueous solution of the silica of solid rocks, as well as of vein stones.

The American Association paper of eight years previous (in 1858), already alluded to as containing the two chemical discoveries that demonstrated the gold-genetic view announced in 1866, will be found in the Association Proceedings for 1858, pp. 163 to 165, under the title, "On the Detection of Nitric Acid in Solution; the Action of Sesqui-salts of Iron upon Indigo and Metallic Gold, etc.," by Henry Wurtz, of Washington, D. C. Both ferric chloride (sublimed crystals) and ferric sulphate (chemically pure) were found to dissolve metallic gold (also platinum) appreciably, even in the cold, and much more rapidly with heat. This was the fundamental fact. The other fact, then novel, though rediscovered afterward by others (Kuhlmann, for example), and now long universally recognized, was that organic matters (filter paper, cellulose, being one material experimented on) reduced ferric solutions to the ferrous state even in the cold.

The whole argument in "Gold Genesis," the memoir of 1866, was based on the proposition that all gold was originally in solution in the waters of the primeval ocean, by the aid of iron persulphate; and on its precipitation therefrom, simultaneously with the reduction of the persulphate to iron sulphides, through the agency of organic life and its products in the ocean. There is ample evidence that life existed in the ocean during the gold producing era antecedent to life on solid land, even if we reject the Eozoon, Palæotrochis, etc. The profound alterations that attended metamorphism generally obliterated all fossil indications, but graphites, and even coaly, lignitic and bituminoid bodies, are found inclosed in crystalline schists. In this paper, and in others that closely followed it (already referred to), this theory was worked out and all objections met. In 1869, still another paper was read to the American Association* in continuation of this and related subjects.

In "Gold Genesis," the remark was introduced, in connection with statements of the known universal presence of gold in pyrites,† that a very important share of the primeval oceanic gold may still be held in solution. Some computations were added, which have been quoted likewise—as in the case of Sterry Hunt—with curious inaccuracy by Professor Lobley (in this case probably at second hand). Then, after allusion to the discovery of silver in sea water, by Malaguti, comes the following: "I would urge that gold be also sought for with renewed precautions. It may be that if we had for the latter tests as delicate and characteristic as for the former, it would have been already detected." It should be added here that Professor Lobley must be deemed as unacquainted with all the papers of the writer referred to above.

Some may think it a presumptuous comparison of small things with great, but the writer himself feels perfectly justified in claiming that, as shown here, he presented in 1866 a generalization, accompanied by a prediction, similar in kind at least to those which have immortalized the names of Newlands and Mendeleef. Newlands, in connection with his first generalization—presented, and unfavorably received and even ridiculed just a generation since, in 1864—predicted germanium.§ Mendeleef subsequently predicted other unknown elements, and urged that they be sought for. These were deductions from one of the most famous of human inductions, independently achieved by these two chemists. Similarly, the present writer presented in 1866 the induction that gold should exist in the ocean, and urged that it should be sought for. Six years after, in 1872, E. Sonstadt § announced its discovery in the ocean.

As to the other fact first published by the writer in 1858, namely, the reduction of ferric solutions by cellulose, and organic matter generally, chemists, the writer thinks, will substantially agree with him that this virtually anticipates the later result that Professor Lobley cites of Mr. R. Daintree, that is, the reduction of a gold solution by cork. The experiments of Professor C. Wilkinson, further referred to, do not appear to the writer to be pertinent to the question of the original mode of aggregation of the gold, which is usually so intimately incorporated with the pyritic mass as to defy the microscope and to indicate undeniably their original joint deposition, by one process of precipitation.

In "Gold Genesis" the ground is taken that isomorphism enters in here, yellow pyrite, galena and

* Compare the article of the present writer, on the "Density of the Earth," in the SCIENTIFIC AMERICAN SUPPLEMENT, No. 940, Jan. 6, 1894, p. 15026.

† References to some of these papers only are at hand just now. American Journal of Mining, vol. iv., pp. 274, 322, 339, 354, 370; vol. v., pp. 18, 30, 114, 130, 142. American Gas Light Journal (edited then by the writer), vol. x., Nov. 16, 1868; and later numbers.

‡ Surprised to find here the name of Hunt, who was always in accord with my own views on these subjects, I have referred to the last edition of his "Chemical and Geological Essays," 1891. I find nothing there about a silicate of gold. On pp. 287-8 he comments as follows upon Sonstadt's verification of my oceanic gold theory: "The views maintained by Lieber, Wurtz, Genth, and Selwyn, as to the solution and redeposition of gold in modern alluvial deposits, seem to be well grounded, and we are led to the conclusion that the circulation of this metal in nature is as easily effected as that of iron or copper. . . . Prof. H. Wurtz, in a paper read to the American Association in 1866, expressed the opinion that the ocean waters contain gold, and urged experiments for its detection. According to his calculations, the total amount of gold hitherto (in 1866) extracted from the earth, and estimated at two thousand million (should be five thousand million) dollars, would give only one dollar for 280,000,000 tons of water." The remainder of the passage contains an extraordinary error of computation, or slip of the pen, on the part of Hunt.

* The only reference that I can now give for this paper of 1869 is American Gas Light Journal, December 16, 1869, and January 3, 1870.

† The chemist Gahn, the preceptor of the great Berzelius, stated, as cited in Bischof's Lehrbuch der Chemischen Geologie, ii., 2,053 (translated): "Of iron pyrites we have none that on exact testing does not show traces of gold." Homberg also stated, in 1709, that pure silver melted with pyrites—even when other chemists had failed to find any gold by other methods—always took up gold. (See Roscoe and Schorlemmer's Chemistry, vol. i., p. 7.)

‡ Sterry Hunt's Systematic Mineralogy, p. 30.

§ Chemical News, Oct. 4, 1872, pp. 159-161.

gold all belonging to the regular or isometric system, and therefore crystallizing together in the same crystal.

To enable his views to be compared with those of Professor Lobley, as in the last paragraph of the latter's paper, the writer ventures to quote here the final postulate of his theory of the formation of gold veins.

"SEVENTH POSTULATE.

"Gold has been concentrated from its first general diffusion throughout the sediments, by alternations of oxidizing and reducing action, dependent upon the alternations of level of the district between elevation into the oxidizing medium of the atmosphere and depression near or beneath the ocean level, the iron sulphides being thus first partially leached out of the heated mass by oxygeniferous waters of atmospheric origin, and collected as auriferous solutions of ferric sulphates in the cavities and fissures produced by contraction during crystallization, and then reduced again by organic solutions (similarly and simultaneously leached into the same cavities) to sulphides, these sulphides being necessarily richer in gold than the first, the superficial portion, thus impoverished and decomposed during elevation, being eroded and removed by aqueous agencies during depression, leaving a new heated surface for renewed and deeper lixiviation and oxidation upon subsequent elevation."

The writer must not be understood as implying, by this partial exhumation of his apparently buried work of three or four decades ago, a complaint on his own part. He is well aware that no cultivator of any branch of science can possibly, at the present day, know or learn all that has been done in such branch. This subject of gold and its relations occupies, however, at this epoch much of the attention of mankind in general; and he does not therefore feel called on to offer any apology for trying to revive his claims to priority. American writers of note have also ignored or forgotten them. One case interesting in connection with the above quoted postulate from "Gold Genesis," might be referred to. Mr. Richard Pearce, in his very important and valuable presidential address to the Institute of Mining Engineers, at Washington, in February, 1890—an address full of original experimental results and suggestions—discusses the subject of the effect on gold, as regards amalgamation, of the alteration from pyrite to limonite—that is, the formation of auriferous gossans. He deems it "not improbable that gold, during such change, is dissolved and again precipitated in a pure state, or in a form free from such impurities as exist in the sulphides." He cites from a paper read to a Colorado society by Mr. R. G. Hills, "an example of this kind, at the Little Annie Mine, San Juan district, giving evidence that gold has been dissolved or leached out at one point, and reprecipitated at another, as a result or concomitant of the alteration of pyrite into limonite." Mr. Pearce then adds suggestions that alkaline chlorides, peroxide of manganese, and sulphuric acid from the oxidation of the pyrite, if all present, might dissolve the gold. Peroxide of manganese, however, is not always present, and if it were, the alkaline chloride would have to be unusually concentrated to effect solution of the gold. It would appear that Mr. Pearce was not aware that ferric sulphate alone, as formed by direct oxidation, is sufficient for solution and transportation of the gold.

Other American metallurgists have occasionally shown that the fact of the ferric gold solution has not been wholly forgotten by all. Thus, for instance, the distinguished metallurgist, Riotte, in a communication in 1880 to the Engineering and Mining Journal, on the "Solubility of Gold," says: "I would finally remind the reader that sulphate of iron (peroxide) will also dissolve gold, especially if the solution contain chloride of iron or of sodium."

A careful computation with the best data attainable, on the basis of 0·9 grain of gold per ton of sea water—about the proportion assigned by Sonstadt—shows that the great ocean should contain gold to the amount of over $80,000,000,000,000,000.

The getting of some of this, by electrolysis, will be one of the problems of the future.

WONDERS OF THE TAMARACK COPPER MINE.

[SPECIAL CORRESPONDENCE OF THE BOSTON TRANSCRIPT.]

OPEECHEE, MICH., August 30, 1894.

LESS than a month ago the deepest mining shaft in the world reached the copper lode in the Tamarack mine. The mine is in itself a wonder, and the stupendous machinery on the surface, the awesome depths of its shafts, the richness of its lode and the size of its dividends render it a most interesting property. Its history is a combination of romance and stern practicality; projected in the mind of one who was laughed at as a dreamer by his associates, it has been developed on the lines he laid out before the first shovelful of earth was turned over on the property, and to-day, barring only its giant neighbor, the Calumet and Hecla, richest among mines, it is the leading dividend-paying property of the great mineral district of Lake Superior.

In 1880 Captain John Daniell interested with himself in the purchase of a tract of mineral land in the township of Calumet, a number of local and Boston capitalists. It had already been demonstrated that the famous Calumet and Hecla conglomerate was a vein of wonderful strength and permanence, and its dip had been calculated at 37½ degrees, while its width was fairly well known. If the vein held its course, it passed under the tract purchased by these men, but at a depth of over 2,000 feet. It required faith and cash to develop a mine under such hitherto unheard-of conditions, but the men and the money were found. The Tamarack Mining Company was organized, and the first earth was turned from the ground in what is now known as No. 1 shaft in February, 1882.

It was estimated from the dip of the Calumet and Hecla vein, as calculated by the engineers, that the lode would be cut at a depth of about 2,250 feet from surface. No time or money was spent in sinking a small shaft or in boring with a diamond drill; a full sized working shaft was planned from the start. The inside measurement of the solid timbering of which the interior of the shaft is composed is eight by twenty-four feet. In this shaft are four compartments—one for ladder and pump, one for lowering men and timber and two for hoisting rock. The ladders are used in ascending or descending for short distances, and in case of accident to the hoisting machinery are capable of being utilized for the entire distance, though a half-mile climb is by no means a pleasant pastime. Sinking was continued steadily, day and night shifts working, for three and a half years, and over a quarter of a million dollars was spent to demonstrate a mere theory. Occasional masses of float copper were struck; in 1882, 363 pounds of copper were secured in this way, and sold at eighteen cents a pound—just double the present selling price. In 1884 the production was 7,435 pounds, and has increased rapidly every year since. The Calumet and Hecla vein was struck at a depth of 2,270 feet—within twenty feet of the estimate originally made—and the fortune and reputation of the projectors of this greatest of modern mining feats were assured.

As soon as the first shaft reached the lode a second was projected, and then a third, while now the fourth shaft is being sunk. Shaft No. 3, which is now the deepest in the world, being a trifle over 4,300 feet in depth at present, was begun three years ago, and reached the vein on August 4 at a depth of 4,185 feet. The vein at this point is some twelve feet thick, much less than its average, and the rock first secured was not as highly mineralized as elsewhere, but within the past week the conditions have changed greatly for the better, and No. 3 shaft is now in as rich rock as at almost any point on the great lode.

A trip down the three-quarters of a mile into the bowels of the earth is a decided novelty. Entering the cage, which is an iron elevator, fitted with all modern safety appliances, and hoisted or lowered by an inch and a half wire cable pas-ing over a great drum in the engine house near the shaft, the signal is given to lower. A separate cage is always used for carrying men, and the rate of speed is less than where rock is hoisted or timber lowered in the other compartments. The trip requires five minutes, and as the cage sinks at a rate of speed equal to that of the swiftest elevator in a modern sky scraper, the dark walls of rock, on which a faint light is thrown by the candles and oil lamps of the party, seem to be swiftly shooting upward while the cage is standing still. At last the bottom is reached. A dozen miners, covered with grime and dust, are busily at work. Power drills fed by compressed air coming almost a mile through iron pipes are tapping the rock petulantly. Men are shoveling the rock blasted from the lode into the cars, which are trundled into the cages and hoisted to surface. The candles throw weird shadows, and as the reflection comes to the mind of the mortal from earth's surface that he is deeper down under the earth's crust than man has ever penetrated before, the desire to ascend to fresh air and sunshine is apt to come uppermost. A few minutes show all that is to be seen, for No. 3 shaft has just reached the lode, and the extensive system of drifts, crosscuts and winzes existing in other shafts of the mine has been but begun down here. The work is all planned for many years to come, and the force of compressed air and the muscle of man will transfer those plans from the paper where they were placed by the busy brain of the engineer into openings in the living rock, inch by inch, but with the same power of never-ceasing persistence which causes the falling drop of water in the course of long ages to wear away the hardest stone.

There is little for the geologist to see in No. 3 shaft except the copper vein at the bottom. The first fifteen feet of the shaft was sunk through the drift, then through a band of trap rock of a hundred feet or more, followed by a seam of amygdaloid. The copper found in a native state in the Lake Superior district occurs in the amygdaloid conglomerate veins. Great masses of pure metal or virgin copper carrying silver in connection are found in the amygdaloid veins, while the conglomerate measures carry the copper in small grains, but in quantities more than sufficient to make their product richer than that of the amygdaloid mines. None of the amygdaloid veins cut in No. 3 shaft carried copper, and were but mere seams. Three belts of conglomerate were cut at varying distances, one of which was recognized as the Allouez belt. This lode is five feet thick in No. 4 shaft, but in No. 3 is merely a seam carrying no copper. The other two belts, being devoid of copper, were not named. The Osceola amygdaloid, so named from the Osceola mine, which is opened upon that lode, will be found under the Calumet and Hecla conglomerate, and is expected to carry a considerable amount of copper.

The depths of the four Tamarack shafts on August 25 were as follows: No. 1, 3,180 feet; No. 2, 3,280 feet; No. 3, 4,200 feet; No. 4, 1,100 feet. This latter shaft, the latest planned and begun, will strike the vein at a depth of about 4,450 feet, and will require two years or more to reach its destination. By that time No. 3 shaft will be a mile or more in depth.

The management of the Tamarack is contemplating changing No. 3 from a vertical to an incline shaft, at a depth of 4,250 feet. At this depth the shaft will be under the lode, which dips at the angle noted, and every foot sunk vertically will take it farther from the vein, necessitating extra work in opening drifts and in tramming rock.

The four shafts of the Tamarack are of practically the same capacity, and from three of them copper rock is now being hoisted. The cage is brought upward from the bottom or from some level higher up, with a loaded car of rock. It is hoisted seventy-five feet above surface, to the top of the rock house standing over the shaft, and the car is pushed off the cage, an empty one pushed on, and the cage shoots swiftly downward for another load. The rock in the car is dumped into a chute, from whence it is fed into a series of crushers, which reduce it to small lumps. By the time it is the required size it has reached the last pocket, whence it is fed into railroad cars that run under upon the surface of the ground, and is then hauled to the shore of Torch Lake, where the stamp mills crush the rock to sand, and the copper, then known as "mineral," is packed in barrels. It then goes to the smelter, whence the pure copper is turned out in great ruddy ingots, the mineral from the stamp mills averaging about seventy-five per cent. refined copper at the smelters.

The machinery required to hoist the rock, lower timber and miners, and to run the crushers in the rock houses, the power drills working half to three-quarters of a mile underground, and in some cases almost a mile distant, and for the machine and carpenter shops on surface, is among the largest and finest in the world. At No. 1 engine house, near the shaft of the same number, are mammoth air compressors, driven by 750 horse power engines, and furnishing compressed air for driving 43 power drills, each of which does the work of a dozen men. In addition to running the drills the compressors furnish power for running the pumps a portion of the time, and also for steam winches handling the heavy timbers required for securing the underground openings. At No. 1 engine house a double-cone hoisting drum is used. This hoists one cage and lowers another simultaneously, effecting a considerable economy in the application of power. At either end the drum tapers at an angle of about thirty-five degrees, thus giving a greater leverage in starting the cages from the lower levels.

At No. 2 shaft a trifling little steam engine of only eighteen hundred horse power drives a little drum 30 feet 6 inches in diameter. Around this drum are coiled layers of inch and a half steel cable aggregating 3,500 feet in length. A loaded cage, weighing with its burden some eight tons, is hoisted by this drum at the rate of 1,100 feet per minute. Fifteen feet above the floor stands the engineer upon a little platform, three levers before him. Through these three levers he puts on steam and cuts it off, throws the drum in or out of gear, and lowers or hoists the cage. The engine that controls the gear alone develops some ten horse power. To lower the cage the drum is thrown out of gear, and allowed to turn backward from the weight of the cage and cable. The speed is regulated by a great band of steel plate a foot wide, half an inch thick and fifty feet in length, which passes over the upper portion of the drum, and is tightened or loosened by steam power. As the cage shoots swiftly downward the friction is such that the hard wood strips under the band brake smoke and occasionally catch fire, necessitating their replacing every few months; the water sprayed on them to prevent their burning being evaporated in steam.

At No. 3 shaft a new engine house is being built which will contain a hoisting gear similar to that at No. 2, except that it will be larger, the diameter of the drum being 37½ feet, making it the largest drum hoisting from the deepest shaft in the world.

Previous to opening copper measures to such extent as to pay for the cost of operation, assessments of $520,000 were levied and paid by the stockholders of the Tamarack. Its last dividend was paid in June, 1894, and the dividends returned to stockholders in the few years the mine has been in operation amount to the tidy sum of $3,870,000, with a strong surplus in the treasury.

From the last annual report issued by the Tamarack company the following suggestive figures are summarized: The production of copper-bearing rock in twelve months was 345,925 tons, which yielded at the stamp mills 21,976,363 pounds of mineral. This in return gave an average of 73·08 per cent. in refined copper at the smelter, netting 16,061,106 pounds of pure metal, which sold for $1,852,252.50. The actual cost of mining, hoisting and smelting this amount of copper, including all operating expenses, was $1,136,152.38, leaving a net mining profit of $721,121.82. From this profit was deducted the cost of copper to the company, 7·08 cents per pound, or with the work of development included, 8·03 cents per pound. The percentage of mineral contained in the rock hoisted was 0·0318, and of refined copper, 0·0232.

The various shafts, drifts and crosscuts of the Tamarack, if placed end to end, would be several miles in length, and all of this work, except the fifty or sixty feet through drift, has been in living rock. The dip of the vein is almost north and south, and the inclination is steady at thirty-seven and one-half degrees for the distance of one and a half miles that the vein has been traced. The remarkable strength and permanence of this vein, known to all mining men as the Calumet and Hecla conglomerate, is the wonder of miners and engineers. No other mineral vein ever exploited has proved of the same strength and permanency. The thickness of the vein varies from eight to forty feet, fifteen to twenty feet being probably a fair average. Some portions of the vein are more highly mineralized than others, but yield an average return of two and a half to three per cent. of refined copper, occasionally giving over five per cent. The conglomerate measure is a sort of hasty pudding rock, in which there are small round pebbles of granitic nature, fragments of sandstone and sand and small particles of copper. There are no ores of copper in the district, though veins of copper ore have been found seventy-five miles to the south and east, on the Marquette iron range. No matter whether the copper is found in masses of many tons weight, as in the Quincy mine at Hancock, on an amygdaloid lode, or in grains ranging in size from small shot to little particles as fine as sand, it is native copper, pure and free from alloy of any metal. The only metal ever found associated with the copper is silver, but the two metals are separate and distinct, though found side by side, and welded to each other from the pressure of ages ago, when the copper-bearing measures were forced from vast depths to the surface of the earth. In the Quincy and Osceola mines the silver product amounts to several thousand dollars per annum, and a considerable of the white metal is found in the Calumet and Hecla lode, in spots.

The Tamarack gives employment to 1,200 men, and this number varies but little the year around. As good stoping ground is opened in No. 3 shaft the force will be increased, and with the advent of No. 4 shaft as a producer, some two and a half years from now, the force will be largely increased. All of the men have steady employment at good wages, and the Tamarack management stands as well with its employes as its shares do with investors. The capital stock of the company is 50,000 shares of a par value of $25 each, but the latest quotations show the stock selling at over $160 per share.

HORACE J. STEVENS.

IT is asserted that Bermuda is the most isolated locality that is inhabited by human beings. It is 700 miles from New York, almost exactly southeast; it is 625 miles almost due east from Cape Hatteras, and hundreds of miles outside the course of European steamships and ships that traffic between the mainland and the West Indies.

[Continued from SUPPLEMENT, No. 978, page 15632.]

METHODS OF MINE TIMBERING.*

By W. H. STORMS, Assistant in the Field.

CONSTRUCTION OF SQUARE SETS.

IN building square sets, the sills, 16 to 20 feet in length, are first laid down on the floor at right angles to the walls. These timbers are the largest in use in the mine, and should properly be as long as they can be handled. At regular intervals shallow depressions are cut across the upper face of the timber one inch in depth and superficially the same size as the posts which are to rest upon the sill. In the center is cut a mortise, two-thirds the square of the post, at least 6×6, and larger as the size of the timber is increased. Into the mortise a tenon on the bottom of the post fits nicely. The sills are laid horizontally and exactly parallel at such distances as may have been determined upon, usually 5 or 6 feet from center to center of the posts. The sets may be placed in the form of squares or rectangles. Two sills having been laid, four posts, constituting the four corners of a set, may be placed in position. They may be of greater length than the posts of sets above, the object being to afford more room overhead on the sill floor, if desirable. A temporary platform is constructed by spiking stout planks to the two sets of posts at right angles to the sills, and placing on them planks or lagging. This staging is built at a suitable height, to enable the men standing thereon to lift the heavy caps and place the ends upon the framed posts. The caps are placed directly above the sills; that is, in a direction extending from wall to wall.

Each post is framed with a tenon both top and bottom; that at the upper end being two-thirds or three-fourths, and that at the bottom, one-third or one-fourth the thickness of the cap. (See the detail drawings.) It is necessary that the bottom of each post shall rest directly upon the top of that in the set next below. All the timbers must be carefully framed, or it will be found that they will not join properly.

Having placed caps upon the posts, the ties may also be lifted into position, crossing from post to post and resting upon them in the same manner as the caps, but at right angles to them. Ordinarily caps are broader on one side than on the other. The broad side is laid upward, the width of which is equal to that of the post, which is square. The tie is equal to the smaller width of the cap. The ties should fit tightly, and if they do not, must be secured by wedging at the ends. The best results are obtained when it is necessary to drive the ties down with mauls.

As the work of extracting the ore proceeds, the timbering keeps pace with it. As the stopes are carried upward, set is built upon set, reaching from one level to another. Temporary working floors are laid, split lagging being used for this purpose. These floors are moved from time to time as the work progresses. Ore broken down on these floors is shoveled into the bins beneath, or onto the sill floor before the bins have been provided, and from there shoveled or dumped into cars and sent to the surface.

When timbers have been placed, the wedges along the walls should be driven up between the plates and walls, and in all other places where needed, to secure firmness and rigidity, and some one man should be detailed to look after them and see that they remain so; for in large stopes the ground is constantly shifting more or less, and the weight being transferred from one point to another causes the wedges to loosen, when they must be again tightened to insure safety.

The size of timbers used in the square set system ranges from 8×8 or 8×10 inches to 20×24 or even 24×28 inches, though timbers of the latter dimensions are often difficult to obtain. When such massive timbers cannot be had, the sets may be constructed on a smaller scale, having a lesser distance between posts, and also less height to the set; thus greater strength is secured by the employment of a larger number of timbers.

Caps encroach upon the posts 2 to 6 inches, according to their dimensions, while ties have a rest of 1 to 4 inches, this being also determined by the size of the timbers. The posts are framed in accordance with the dimensions determined upon, which must be constant, to secure uniformity, whether the post be 16×16 or 24×24. As all caps are of the same length and all ties of an equal length, it is evident that if the tenons on the posts vary with any difference in the size of the posts (should any difference occur), the system would soon be out of line. As the timbers used are all sawed, it should not be difficult to secure them having a uniform size for any single stope. In any event, the tenons at the top and bottom of the post must have a uniform size regardless of the dimensions of the post. For instance, should 18 inch posts be in use on any particular level, framed with 12 inch tenons, if from necessity or choice a 20 inch or 24 inch post be introduced in the sets, it must have a 12 inch tenon, corresponding with the others. Square timbers are usually framed with gang saws, and are, therefore, uniform, and any particular stick, whether post, cap, or tie, may be used in any portion of the mine.

Posts and caps which come in contact with the wall plate are mostly framed by hand, to order, careful measurement having first been made to determine the exact dimensions. Caps which meet the plate within less than two-thirds the width of the set are frequently made continuous from the second post. Wall plates are cut in sections, the length of which is determined by the conditions in the mine. These are also mostly framed by hand. The manner of framing and fitting these timbers will be understood by reference to the drawings.

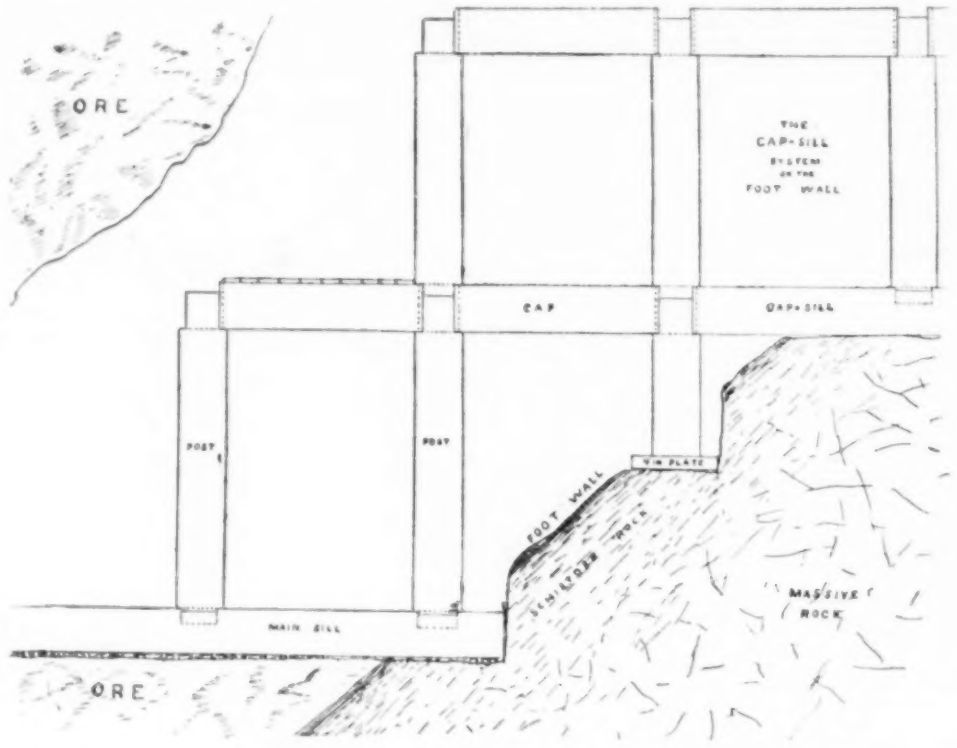
CAP SILLS AND THEIR USE.

Cap sills are often used in preference to wall plates on the foot wall of a vein. They are applicable to small stopes as well as great chambers. As the name implies, these timbers are simply an extension of the cap from the post nearest the foot wall to the wall where it rests upon a hitch cut in the wall (2 feet or more, according to the character of the ground). It then forms a sill for the post of the set next above, as illustrated in the accompanying drawing.

* From Bulletin No. 2, California State Mining Bureau. Dr. J. J. Crawford, State Mineralogist.

AN IMPROVED SEAT FOR THE POST ON THE SILL.

The method commonly in use for cutting a seat for a post in the sill, that of cutting a section an inch deep entirely across the face of the sill, in the center of which is a mortise to admit the tenon of the post, has been superseded in some mines by a new practice, which has many advantages, particularly the ease with which all rock and other foreign substance may be removed when ready to set the post. The tie or girt is let in on each side, they being cut out to the depth of one inch at the ends. The drawing will explain the idea better than a description. The posts have a tenon one inch only in depth. A longer tenon would afford no additional security or firmness.



RECOVERING LOST GROUND.

A great deal of good ore is sometimes lost by the settling of large veins upon the timbers of the first few floors of a stope so heavily as to throw the timbers out of line, when bulkheading and filling in must at once be resorted to, to prevent caving. In the Anaconda Mine, of Butte City, Montana, a case of this kind occurred. The timbers on the sill floor were forced out of line, and it was evident that a disastrous cave was imminent. The stope was packed full of timber and waste as rapidly as possible and the level abandoned. A drift was then run from a cross cut in the foot wall, 60 feet from the vein, and in this lateral drift at distances of 60 feet, and directly opposite the chutes in the abandoned stope, as established by the mine surveyor, a square set was placed. A raise was then carried up on an incline to the vein, where it was still intact above the filled stope from each of these points. These raises were timbered with square sets, which in section would present the appearance of a series of steps. The rock in which the drift was run was solid granite, but as the foot wall was approached it was much decomposed and required substantial

timbering. Had the foot wall country rock been firm and hard, no timber would have been necessary, except at the stand on the floor of the drift where the loading chute was constructed and at the junction of the winzes and foot wall of the vein. Through the winzes thus made the lost ore was almost entirely recovered.

DIAGONAL BRACES.

These timbers are necessary in heavy ground. It must be borne in mind that they, in a measure, perform the office of stulls, and should not be placed at right angles to the hanging wall, but at a higher angle. For instance, supposing the inclination of the hanging wall to be 45 degrees, the diagonal braces should stand at 55 degrees. The height and width of the sets must be determined by the desired inclination to be given the diagonal or angle braces, and before this can be determined the inclination of the hanging wall must be known. The angle braces may be of the same size as the posts or a little smaller. These timbers are not mortised nor framed with tenons, but are slipped in sideways and secured by thin wedges, if they are not tight when put in place.

SIDE PRESSURE.

When the pressure is greater, apparently, from the side than from overhead, the method of framing and joining these timbers is somewhat different. The cap becomes the post. An examination of the drawings will convey an idea of the system employed under these conditions. The tenons at each end of the cap in this case are exactly the same size, while the tie is also provided with a tenon, but of different style from that used where the timbers are framed to resist top pressure. The placing of wall plates and angle braces is the same in each system. The accompanying drawings, showing a horizontal and vertical section of a corner in both the top and side pressure systems, show plainly the details of both methods.

BULKHEADS AND CRIBS.

It frequently occurs that bulkheads of solid timber, or cribs filled with rock, have to be built to sustain sinking roofs which have already been substantially timbered. Bulkheads are formed by laying massive squared timbers side by side, filling the space between sets. Upon these are laid a second layer at right

angles to the first, and so on from floor to roof of the stope. Cribs are constructed by building up timbers in the form of a hollow square or rectangle, the interior space being filled with large broken rock, and also extends from floor to roof. Either of these devices forms a very substantial support to settling ground, though sometimes inefficient.

Bulkheads of solid masonry are sometimes built in mine workings to stop a heavy influx of water. They should be constructed with the greatest care and in the most substantial manner possible to prevent future collapse. When it becomes necessary to build a bulkhead of this kind a section should be cut in the floor, sides, and roof of the drift, and the masonry extended into these spaces. Water bulkheads are some-

time - built of dry timbers, which, swelling, effectually shut off the influx of water.

An instance recently came to the knowledge of the writer in which a large flow of water followed the cutting of a subterranean reservoir by a power drill. As usual in such cases, wooden plugs were inserted and driven in, but to no purpose, the force of the water driving them out. The protection of a bulkhead seemed necessary to prevent the flooding of the mine. An experiment was first tried, which, proving successful, rendered the bulkhead unnecessary. A section of pipe provided with a globe valve was inserted in the hole, the valve remaining open until the pipe was firmly secured by wooden braces and tightly wedged in the rock. The valve was then closed and the flow shut off. Provision then being made to handle the water, the valve was opened partly and the reservoir drained. It seems that this plan might be adopted with advantage where the influx of water interferes with the construction and completion of a watertight bulkhead, for at times the flow of water is so great that it is almost impossible to construct a bulkhead, owing to the pressure of the water back of it.

TIMBERING AT THE UTICA MINE.

The largest known body of ore in California to-day is in the Utica-Stickles Mine, at Angles Camp, Calaveras County. Its extent is, as yet, unknown. The workings have thus far exposed a mass of gold-bearing rock ranging from 40 to more than 100 feet broad, over 400 feet high, and exceeding 1,000 feet in length. Stopes of this size require a very substantial system of timbering, and the square set system, which has been described at length, is exactly suited to its requirements. It is not in use, however, but in its stead another system, which is quite similar, and based on exactly the same principles, still having very important differences. A study of the accompanying timber sketch of the Utica Mine will suffice to make an understanding of the method plain.

The timber used in this mine is exclusively round, peeled pine logs, which are delivered by contract at the surface works. The cost of these logs, I am informed, is 10 cents for each inch of diameter, making a 16-foot 18-inch log cost $1.80, and a 24-inch log $2.40. These timbers are all cut into two lengths of 8 feet each. They are mostly over 18 inches in diameter, and occasionally are found as large as 28 and 30 inches in diameter. The posts are framed to 14 inches, top and bottom, the tenon being 4 inches high. Caps are framed to 14 inches at either end, the tenon being 6 inches long. Thus it will be seen when two adjacent caps are placed on a post the tenons will not meet, but will have a 2-inch space between them. This space is filled by driving in a section of 2-inch plank 14 inches square. At the junction of caps and posts, it will be noticed, are two ties in place of one, as in the square set system. These ties range from a foot to 16 inches in diameter, and are about 4 feet in length. The lower one has a horn 4 inches in length on its upper half. These projections rest upon the shoulders of the posts. The upper tie is tightly wedged between the posts, as shown in the drawing. This system has replaced that formerly in use at the Utica Mine, in which the posts were 16 feet high; caps being let into the sides at 8 feet and others resting on the top. The new system is much preferred and has many advantages over the old. (A 30-inch post 16 feet in length weighed over 3,300 pounds.) In the present system the posts and caps weigh from 700 to over 1,000 pounds each.

Owing to the impossibility of procuring round timbers that are exactly uniform in size, the Utica system involves a vast amount of dressing timbers underground to secure the necessary uniformity in joining. While the system is one affording great strength when properly placed, it would seem to possess no advantages over the square set system, and to be more troublesome, cumbersome, and, in the writer's opinion, more expensive than the latter, though the first cost of round timber is less than that of sawed square timber.

No wall plates, excepting short single pieces, are employed, and no sills are laid upon the levels of the floors. It would appear that neglect to provide sills will in time prove a great disadvantage in connecting the stopes from level to level.

HANDLING TIMBERS.

The manner of handling timbers at mines depends to a great extent on the size and number of timbers used, and on the character of the shaft, whether it be vertical or inclined. In drift mines and mineral deposits which lie nearly horizontal, they are sent in on flat cars (trolleys) built for the purpose. When cages are used in vertical shafts the timbers are set upright on the floor of the cage, lashed together, and lowered into the mine. At inclines it is a common practice to load the timbers into the skip and lower them down the shaft in that way to the desired point.

At the Utica Mine the heavy timbers are handled quickly and easily on the surface. They are sent from the framing machine to the shafts on trolleys. Two men are kept busy a great deal of the time in sending timbers underground. A number of stout chains 8 feet in length are provided. In the center of each chain is a 4-inch ring, and at each end a dog, having a point projecting at about 70 degrees, 4 inches in length. One of these dogs is driven into the side of a post or cap somewhat above the center. The chain is passed over the end of the timber and the other dog is driven into the opposite side. A spike 6 or 8 inches long, having a 5 foot piece of rope attached, is driven well into the lower end of the timber, and it is ready to lower into the mine. Beneath the skips are stout chains with rings. An extra chain having hooks at the ends is at hand. This forms the connecting link between the chain beneath the skip and that attached to the timber. Having been securely hooked, the skip is raised slowly, lifting the timber from the platform. The rope and spike at the bottom are used to bring the timber to a standstill before the skip is lowered. Having reached the level where it is wanted, the rope again comes into use in landing the timber at the station.

The Utica shaft is almost vertical. This process, while a convenient and quick way of handling these heavy timbers, cannot well be used in shafts departing very far from the perpendicular, unless a slide of plank be laid between the guides or runway of the skip, and it would then be advisable to line the slides with strips of flat iron. It would appear that timbers might be handled in this manner in shafts having as low an inclination as 35 degrees, particularly if the slide be lubricated. It is certainly a superior method to that of loading the timbers into skips, which involves much difficulty, particularly in landing them at stations. Most mines have blocks and tackle at the stations, secured to heavy timbers overhead, for unloading timbers from skips.

It is always a good plan, where possible, to have complete connection from level to level by means of winzes in veins requiring very large timbers. The timbers may then be unloaded on the level above where they are to be used and lowered through the winze nearest the stope where they are to be placed, and to the particular floor of the stope where they are required. Winzes for this purpose should have, if possible, an inclination of 65 degrees. Where the slope is too low for them to run, however, the timbers may be dragged down, which is certainly much cheaper and easier than hauling them up.

All timbers should be framed on the surface where possible, as it saves much time and trouble. Gang saws are much to be preferred to any other method of framing timbers for square sets. The timbers can, in this way, be framed as exactly, if not more so, than by hand, and in one-tenth of the time.

In mines where cages are used, when it is necessary to send long timbers down into the mine, as sills for square sets, or long plates, much time is saved by boring an auger hole through the timber near the end and passing an iron bar (⅞ inch) through it. The ends of the bar are provided with threads and nuts. These ends pass through the ends of a U-shaped frame, forming a large clevis. The clevis is attached by a chain to the bottom of the cage, and in this manner lowered to the point desired. The principle is the same as that employed at the Utica Mine. The drawing on page 15646 will convey an idea of the device above described.

IMPROVED HYDRAULIC TURNTABLE.

OUR illustration shows a hydraulic turntable, designed by M. G. Francois, engineer of the Acieries, Forges, et Ateliers de la Biesme, of Bouffioulx, near Chatelineau, in Belgium, and exhibited by that firm at the Antwerp Exhibition. The application of hydraulic power to turntables renders it possible for them to have absolute stability at rest, and yet for them to be easily turned. Few turntables have both of these qualities, which ought to be considered essential for them, while many have neither. These results can be obtained by hydraulic power, because by it the whole table can be lifted, so that it gyrates on a central pivot, instead of having to run on wheels or rollers. When no longer required to turn, the pivot can be lowered, and if it were considered necessary, the turntable could then be supported round the whole of its circumference. By suppressing the rollers and roller path, the turntable is more easily constructed and erected, and less likely to get out of order, and there are several minor advantages—for instance, less lubrication is required, and the pit is less likely to fill with water during heavy rains.

Fig. 1 is a cross section of the turntable, Fig. 2 is a plan, with the flooring partly removed, and Fig. 3 is a section showing the connection of the hydraulic valves with the accumulator on one hand and with the cylinder under the center of the turntable on the other. This hydraulic cylinder, marked A, in Fig. 1, is suspended from a steel frame, E, carried by wooden sleepers which rest on the ground. This frame is preferably made in the form of a cross; and it supports at its ends the bearing blocks, T, on which the turntable, D, usually rests. The hollow piston, B, which is turned conically at its upper end, is firmly secured to the table, D, while its lower end is inserted into the cylinder, A. At the foot of the piston is a small valve, C, whose stem rests on the bottom of the cylinder. The valve is thus kept open as long as the turntable is at rest. A tube, F, connects the space inside the piston, and the cavity at the bottom of the cylinder, with the valves, Q and R, which are also placed in communication with the accumulator, N, by means of the tube, O. The construction of the accumulator will be clearly seen from the drawing.

When the turntable is at rest, the handle, L, fits into a groove in its rim, and serves to lock it in position. It also serves to open and shut the valves, Q and R, by means of the levers, J, K, and H. The stems of these valves are connected on either side with the bar, I, which rocks on a central pivot in such a manner that when one is open the other must necessarily be closed. To lift the turntable, L is put over into the position shown by dotted lines. This opens the valve, Q, while closing R, puts the two tubes, O and F, in connection, and through them connects the accumulator with the cylinder, A, and the piston, B. The

Fig. 1

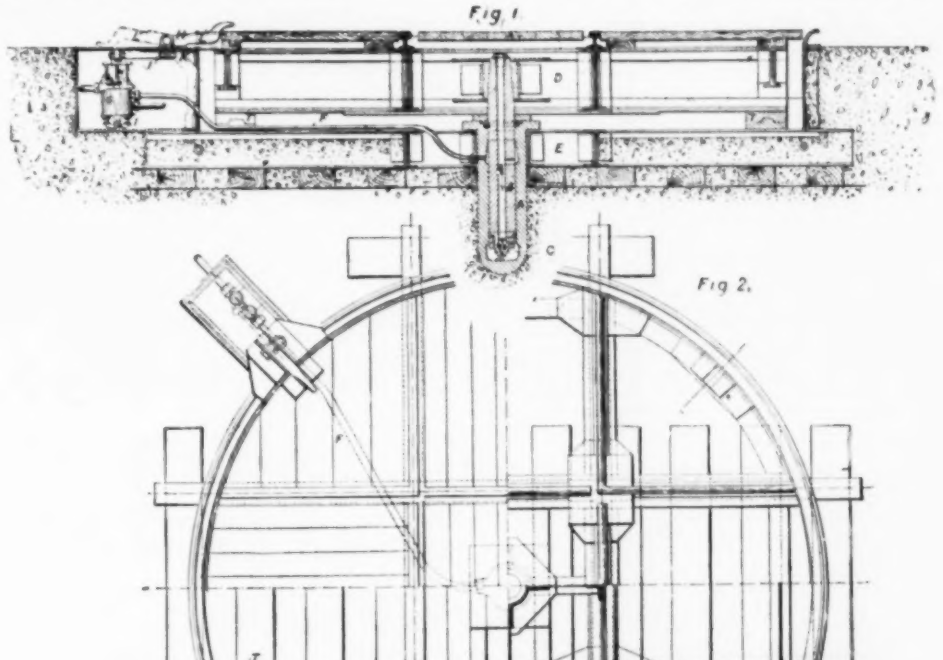
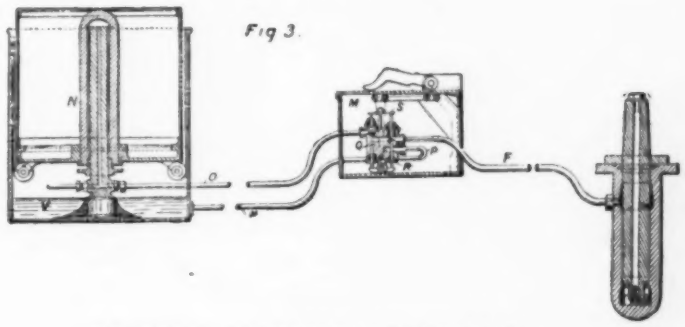


Fig. 2.

Fig. 3.



IMPROVED HYDRAULIC TURNTABLE.

water from the accumulator goes down the interior of the piston and passes through the valve, C, at its lower end into the cavity at the bottom of the cylinder, lifting the piston and consequently the turntable. Directly the latter ceases to rest on the bearing blocks, T, the stem of the valves, C, is no longer in contact with the bottom of the cylinder. This closes C, which stops the admission of water to the cylinder, and consequently the upward movement of the piston, so that the table is only lifted sufficiently to be clear of the blocks, T.

The whole table then bears on the cushion of water which is under the piston; and even when there is an exceptionally heavy wagon on it, a man can easily turn it with one hand. As soon as the table has been turned to the desired position, the handle L is put back. This opens the valve, R, which allows the water to escape from the cavity at the bottom of the cylinder, and to flow through the pipe, P, into the receptacle, V. The removal of the water allows the table to descend, and again to bear on the supports, T. As the quantity of water used is very trifling, the raising and lowering of the table is almost instantaneous. In the Exhibition a hand pump is attached to the accumulator, and as the liquid is used over and over again, a mixture of water and glycerine, or any other fluid, may be substituted for water, if considered preferable. —The Engineer, London.

AUTOMOBILE CARRIAGES.

THE COMPETITION ORGANIZED BY THE PETIT JOURNAL.

IN organizing the competition of carriages without horses, the Petit Journal has taken a happy and interesting initiative, which, moreover, is in conformity with those constant endeavors to which the success of this popular organ is due, viz., to urge forward the development of open air exercises by cycling and walking, and the development of the social well being by locomotion, individual or collective, facilitated upon the highways at the will of each. After the cycle race of Paris Brest in 1891 and that of Paris-Belfort in the same year, the race of carriages without horses of 1894 was the third test of a series that we trust may be long and prosperous. The announcement of this competition was made on the 19th of December with a most simple programme, which in substance was as follows: The competition to be international; mechanical propellers of all sorts; carriages of all forms; number of seats ad libitum, with a minimum accommodation for two passengers; preliminary experiments over a distance of about 30 miles with a speed of 7·5 miles an hour, without a greater speed being taken into account; definitive test upon the road from Paris to Rouen, a distance of 75 miles; engagements accepted from December 29, 1893, to April 30, 1894; competition reserved exclusively for inventors and builders of mechanical carriages; the first prize to be awarded to the carriage that shall fulfill the conditions of being free from danger, easily manageable by the occupants, and not costing too much upon the route.

The carriages were judged exclusively by the editorial and business staff of the Petit Journal, in connection, in an advisory way, with a certain number of engineers who were witnesses of the experiments and gave their technical opinions and the results of their observations to the juries that they accompanied in the different tests.

Ten thousand francs were to be distributed in prizes. The first prize of 5,000 francs was offered by the Petit Journal; four other prizes, of the respective values of 2,000, 1,500, 1,000 and 500 francs, were due to the liberality of Mr. Marinoni.

The entries registered up to the date of April 30 reached the imposing number of one hundred and two vehicles, but at the moment of the tests that took place on the 19th, 20th, 21st and 23d of July, only forty-seven competitors presented themselves. Time, which is a great master, successively eliminated all the fanciful contrivances, such as gravity motors, with levers, utilizing the weight of the passengers carriages utilizing steam, compressed air or gas indistinctly (sic), and all the competitors whose systems were ill adapted for undergoing the severe tests imposed by the Petit Journal. Time eliminated likewise all those who, having presumed too much upon their forces, were not ready after the delay asked for, despite a first postponement of the date of the experiments, made at the request of those interested, the competition having been fixed in the first place for the 9th of June. The programme was faithfully and punctually carried out.

The first day of the preliminary test (July 18) saw 21 competitors entered, 17 of which took part in the race over four distinct courses drawn by lot. Thirteen carriages were admitted to take part in the definitive tests.

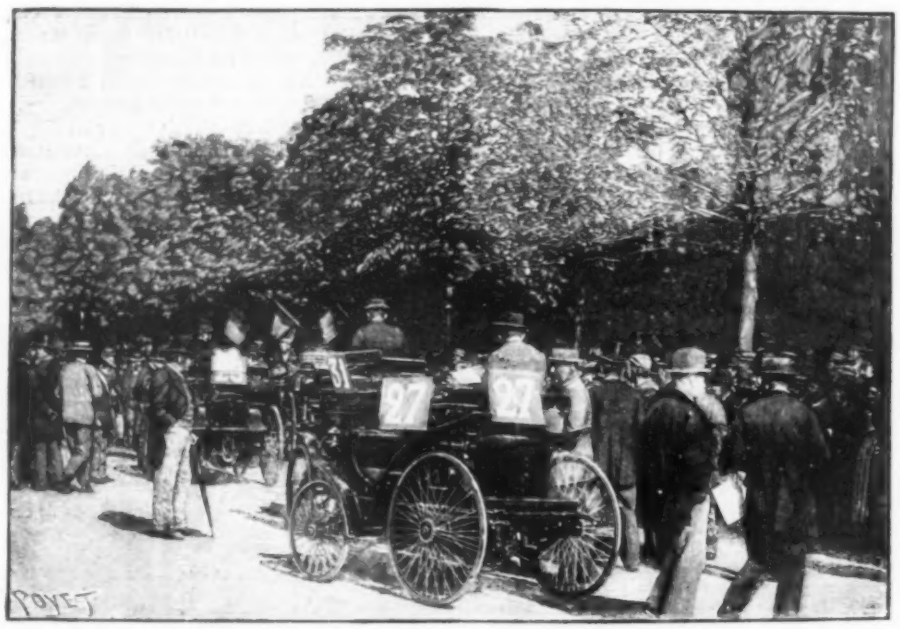
On the second day the 27 competitors that had entered a few days before were reduced to 20, only six of which started and were all admitted to the definitive tests. The third day, which was reserved for those late on the preceding days, saw present but two competitors that were admitted. This carried the total number of vehicles capable of participating in the final tests to 21.

This is a most satisfactory result when we take into account the special difficulties of the problem.

What, in fact, are the motive systems, few in number, to which recourse can be had for the propulsion of an autonomous vehicle? They can be divided into two classes, according as the energy necessary for such propulsion is stored up in a reservoir ready to produce its action at any given moment, with a power instantly variable at will, or as such energy is produced at every instant through the utilization (generally in the form of fuel) of an energy of chemical affinity or of combination which finds, right in the air that surrounds us, the complementary combustive indispensable.

In the first class may be arranged springs, compressed air and electric accumulators. The feeble storage power of springs renders them inapplicable. The same is the case with compressed air, and also, taking distance into account, with electric accumulators.

It requires, moreover, for all reservoirs of energy, charging works, that are now, and will be for a long time, lacking, whatever be the process employed. Every time the carriage, by destination, will be obliged to furnish long trips without re-entering the station. This explains the absence of electric carriages from the Petit Journal's competition. The carriage with electric accumulators is, in our opinion, the coach of the future, but of a remote one. It cannot pretend to the role of an excursion carriage.



FIRST DAY OF THE RACE OF THE AUTOMOBILE CARRIAGES—PREPARATION FOR THE START AT THE BOULEVARD MAILLOT, NEUILLY, JULY 19, 1894

In the second class may be arranged the motive systems that produce their energy directly without previous storage, and that utilize the energy of chemical affinity of a combustible in passing through heat either directly (petroleum, gasoline and hot air motors) or indirectly, in passing through steam produced by the combustion of coal, coke or petroleum, or even through the vapor of petroleum produced by the combustion of such vapor.

Petroleum vapor motors are not yet much employed, and hot air motors heated by coke are too heavy and too cumbersome, and lack flexibility in their power. They are, therefore, naturally eliminated.

Nothing more that is possible remains (and the competition has demonstrated it) but the following systems: (1) Petroleum motors; (2) steam motors heated with coke; (3) steam motors heated with petroleum.

Coke and petroleum are fuels that are met with everywhere, and are easily stored, and of a reasonable price, and water is rarely wanting. These three systems are, therefore, sensibly equivalent from this point of view.

It is the ingenuity of the amateur and the skill of the builder that can establish differences that it is well not to prejudge. It is necessary to know all the conditions of the operation of the system.

The vehicles that underwent all the tests successfully were fifteen in number, thus divided: Petroleum and gasoline motors, 13; steam motors heated with coke, 2.

The fifteen fortunate competitors, starting from Paris at 8 o'clock in the morning, reached Rouen within the limits fixed by the competition, with a genuine speed much greater than 7·5 miles an hour, since the commercial speed (stoppages included) of the slowest vehicle exceeded this figure.

The following is a list of these fifteen carriages, by order of arrival and by hour:

No.	4	De Dion, 4-passenger,	steam,	5 h. 40 m.
"	65	Peugeot,	petroleum,	5 h. 40 m.
"	28	"	"	5 h. 50 m.
"	13	Penhard & Levassor, 4-pas.,	pet.,	6 h. 3 m.
"	31	Peugeot, 5-passenger,	petroleum,	6 h. 7 m.
"	42	Le Brun, 4	"	6 h. 24 m.
"	15	Penhard & Levassor, 2-pas.,	pet.,	6 h. 30 m.
"	64	"	4 " "	6 h. 49 m.
"	54	De Bourmont,	4 " "	7 h. 1 m.
"	30	Peugeot,	3 " "	7 h. 2 m.
"	24	Vacheron,	2 " gasol.	7 h. 3 m.
"	27	Peugeot,	2 " "	7 h. 5 m.
"	14	Penhard & Lavassor,	4 " pet.,	7 h. 10 m.
"	85	Roger,	4 " "	8 h. 9 m.
"	60	Le Blaut,	8 " steam,	8 h. 50 m.

These are the systems, which have already been seen and have for a long time been experimented with, that divided the prize of 10,000 francs. Such a result had long been foreseen.

In order to complete the foregoing account, it has seemed to us useful and interesting to reproduce some photographs representing the prize carriages, in accompanying them with a brief description bringing into relief the principal arrangements of each system. We adopt for our classification the order of the awards so judiciously made by the Petit Journal.

Nos. 15 and 64, petroleum carriages of Messrs. Pan-

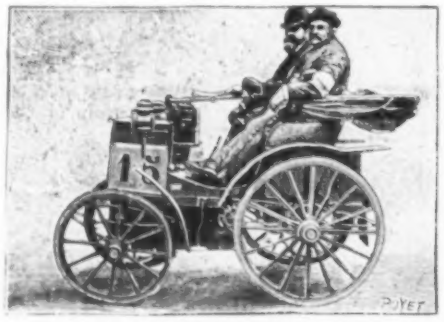


FIG. 1.—PANHARD & LEVASSOR'S PETROLEUM CARRIAGE FOR TWO PASSENGERS.

FIG. 2.—PANHARD & LEVASSOR'S PETROLEUM CARRIAGE FOR FOUR PASSENGERS.

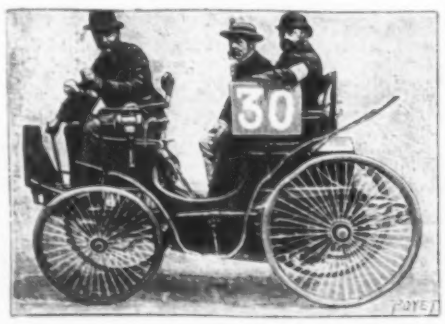


FIG. 3.—PEUGEOT BROS.' SONS' PETROLEUM CARRIAGE FOR THREE PASSENGERS.

FIG. 4.—PEUGEOT BROS.' SONS' PETROLEUM CARRIAGE FOR FOUR PASSENGERS.

hard & Levassor, first prize of 2,500 francs, divided equally with the Messrs. Peugeot Sons. We reproduce but two of the four carriages presented at the competition, and that all arrived at Rouen in less than eleven hours (Figs. 1 and 2). All of these carriages utilize the Daimler two-cylinder gasoline motor, placed in front of the vehicle, and thus rendered very easily accessible. This motor, whose axis is parallel with that of the carriage, runs at a constant angular velocity of 700 revolutions per minute, and actuates the hind wheels through a friction gearing and a train of wheels that permits of running at three different normal speeds of about 3, 5, 7, and 10·5 miles an hour. The intermediate speeds are obtained through the sliding of a friction socket skillfully maneuvered by the driver through the aid of a pedal. The brake, which is very powerful, and of the Lemoine pattern, is controlled by a pedal. It acts upon the intermediate axle, and this prevents the wear and the stripping off of the rubber tires with which the wheels of the carriage are often provided. In case of urgency or for steep slopes, the wheels are acted upon directly by means of a block brake controlled by a lever arranged upon the right side of the carriage within reach of the driver's hand. The maneuvering of the brakes automatically ungears the motor, which continues to revolve despite the stopping of the vehicle. We might point out many other ingenious arrangements apropos of the steering, which for four (Fig. 4), prize of 2,500 francs, divided equally with Messrs. Panhard & Levassor. We have already described the Peugeot petroleum carriage, and therefore need not repeat what we have said. The principal difference between the carriages of Messrs. Panhard & Levassor and those of the Messrs. Peugeot resides in the place assigned the motor, which is here mounted in the rear. The qualities of these vehicles are equivalent to those of the carriages with which the first prize was divided.

No. 4. Messrs. De Dion, Bouton & Co.'s Victoria buggy, prize of 2,000 francs.—The system presented by Messrs. De Dion, Bouton & Co. may be classed among those road locomotives of which a few specimens were seen thirty years ago, before the invention of tramways. This traction locomotive (Fig. 5) is provided in the rear with a fore-carriage circle mounted upon springs and designed to receive the fore-carriage of any sort of vehicle after the latter's front wheels have been removed.

The locomotive is provided with a multitubular circulating boiler of the De Dion, Bouton & Co. system, which supplies a 20 horse power compound motor that is capable of becoming a direct admission one in difficult passages. The vehicle, in running order, weighs 4,400 pounds, and carries a supply of 175 pounds of coke and 880 of water. The throwing into and out of gear is effected through a system of shafts with Cardan joints that traverse the journals and control the wheels externally, thus allowing the latter to obey all the inequalities of the ground, and the springs to yield without interfering with their respective motions, which thus remain perfectly independent.

In hauling 2,200 pounds, the vehicle is capable of reaching a speed of 18 miles an hour on a level and favorable roadway, and 10·5 miles an hour in ascending a gradient of from 8 to 10 per cent. More powerful and less speedy locomotives arranged upon the same principle are capable of hauling at least 22,000 pounds at a speed of 5 miles an hour. This system will be able to render services in war for the carriage of ammunition, provisions, etc. In the race from Paris to Rouen, this vehicle was the first to arrive, and exhibited qualities of resistance and speed that the petroleum carriages failed to attain to the same degree; but it is wanting in the lightness, elegance and conveniences offered by the petroleum vehicles, and so it was awarded only the second prize.

No. 60, Mr. Maurice le Blaut's steam carriage, third prize of 1,500 francs.—This carriage responded but imperfectly to the conditions of the programme of the competition. It is an omnibus for nine passengers, provided with a Serpollet boiler; is quite heavy in form and appearance (Fig. 6), and is better adapted, it seems to us, to a common carriage service, since the vehicle, in running order, weighs more than four tons, thus distributed:

Carriage, empty	5,850	pounds.
Tools and brake	220	"
Ten passengers, say	1,500	"
Engineman	150	"
Coal	440	"
Water, 150 gals	1,300	"
Total	9,460	"

According to Mr. Le Blaut, the consumption is 35 pounds of water and from 10 to 12 pounds of coal per mile, which seems to indicate a pretty poor utilization of the boiler, which vaporizes but about 3 pounds of water per pound of coal. It is well to recognize that it is a question of steam superheated at quite a high temperature. The grate of the type experimented with presented an inadequate surface and quickly became clogged with clinkers.

No. 24, Mr. Vacheron's single seat carriage, fourth prize of 1,000 francs, divided with Mr. Le Brun.—This carriage (Fig. 7) comprises only some modifications of detail of the type whence derived (Panhard & Levassor), particularly in the substitution of a hand wheel for a lever in the steering device.

No. 42, Mr. Le Brun's two-seat petroleum carriage, fourth prize of 1,000 francs, divided with Mr. Vache-

FIG. 5.—DE DION, BOUTON & CO.'S STEAM ROAD LOCOMOTIVE

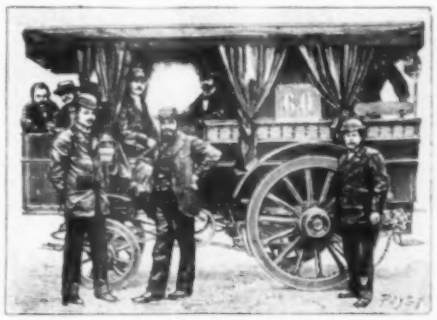


FIG. 6.—MAURICE LE BLAUT'S STEAM CARRIAGE FOR NINE PASSENGERS.

FIG. 7.—VACHERON'S PETROLEUM CARRIAGE FOR TWO PASSENGERS.

FIG. 8.—LE BRUN'S PETROLEUM CARRIAGE FOR FOUR PASSENGERS.

FIG. 9.—ROGER'S PETROLEUM CARRIAGE FOR FOUR PASSENGERS.

FIG. 10.—SCOTTE'S STEAM CARRIAGE FOR EIGHT PASSENGERS.

FIG. 11.—DU MONTAIS' STEAM CARRIAGE.

FIG. 12.—GAUTIER'S PETROLEUM CARRIAGE FOR FOUR PASSENGERS.

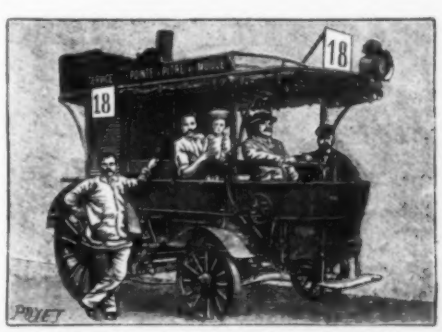


FIG. 13.—ARCHDEACON'S STEAM CARRIAGE FOR SIX PASSENGERS.

of the starting of the gasoline motor, of the carburetor, of the process of stifling the noise produced by the exhaust, etc., but space fails us, and we can only say a few words as to the vehicle as a whole.

The weight of a one-seat carriage, in running order, is about 1,540 pounds, and in a two-seat one, 1,700. The power of the first is 1,740 foot pounds per second, and that of the other is from 2,030 to 2,175.

The cooling of the cylinders of the motor is assured by a circulation of air contained in a reservoir of 2,440 cubic inches capacity. This water becomes heated and vaporized, especially during the summer, so it is necessary to replace it at the rate of from 420 to 600 cubic inches per hour of running. The gasoline employed in the Daimler motor has a density of from 0·7 to 0·705. The reservoir that contains it, and which is placed in front, suffices for a run of 48 miles, but more than 180 miles can be made by arranging a supplementary reservoir in the rear. The mean consumption is about 10 cubic inches to the mile.

It is not for us to pronounce a eulogium upon Messrs. Panhard & Levassor's carriages in this place, and to dwell upon their convenience, speed, endurance, comfort, etc. The result of the competition speaks for us.

Nos. 30 and 65, Messrs. Peugeot Brothers' Sons' gasoline carriages, coach for three passengers (Fig. 3) and

ron.—This, exclusive of a few details, is a carriage identical with those constructed by the Messrs. Peugeot (Fig. 8).

No. 85, Mr. E. Roger's two-seat petroleum carriage, fifth prize of 500 francs.—Mr. Roger's carriage (Fig. 9) is a gasoline one in which the Daimler motor is replaced by a motor of the Benz system, placed in a box in the rear.

The Victoria two-passenger type, capable of receiving a seat in front for a third person, employs a 3 horse power motor, and, on a level, can make from 10 to 12 miles an hour.

Through a proper reduction of speed, gradients of 10 to 100 can be ascended. The vehicle is 9 feet in height, 5 in width, and weighs about 1,400 pounds. The supply of gasoline is sufficient for a run of from 60 to 70 miles. The control of the motion and the system of steering present interesting peculiarities that we cannot here expatiate upon without exceeding our limits. After the carriages that disputed the first prize, it was one of those that best filled the bill of the competition, and it well merited the modest prize that it obtained.

No. 10, Mr. J. Scotte's steam carriage for eight persons, prize of 500 francs.—In this vehicle the boiler is of the vertical type, of the Field system, registered at 120 pounds to the square inch (Fig. 10). The two-

cylinder motor, with slide distribution, makes from 300 to 500 revolutions per minute and develops 5 horse power. The transmission of motion to the driving wheels placed behind is effected through an endless chain and a differential gearing. The carriage is 15 feet in length, 6 in width, and weighs, when empty, 3,700 pounds. With 660 pounds of water, 440 of coal, seven passengers, and the engine man, the total weight reaches 5,940 pounds. The carriage has the form of a brake provided with a top, and with curtains for which windows may be substituted so as to make a closed omnibus of it. An upper railing permits of the storage of baggage on long trips. The consumption of water is from 3 to 4 gallons per mile in plains and from 16 to 20 in mountainous districts. The consumption of coal is 6 and 10 pounds under the same circumstances. A slight accident that happened to one of the plugs of the boiler tubes put the motor out of service near Vernon, and prevented the carriage from attaining the object of its trip at the time of the definitive tests. The results obtained in the other trips made by Mr. Scotte demonstrate that his carriage, although not precisely answering the conditions of the competition, nevertheless merited an encouragement.

No. 61, Mr. Roger de Montais' petroleum heated steam carriage, honorable mention, with silver gilt medal.—This carriage (Fig. 11) is a tricycle for two persons, and the weight of which does not exceed 800 pounds. The steam is produced by the combustion of petroleum through the aid of 26 burners regulated by the same rack and a single handle. These burners are placed beneath a boiler 18 inches in diameter and 18 in height traversed by 26 copper tubes that form so many draught chimneys for the burners, whose heat they receive and transmit to the water. The entrance of the petroleum into the burners is regulated automatically. The consumption of petroleum is 2 quarts per hour. The boiler vaporizes 65 pounds of water per hour, and the reservoir has a capacity of 16 gallons, which corresponds to a run of about two hours. The process of heating employed does away with the necessity of a chimney.

It takes 17 minutes to put the boiler under pressure, and this once effected, the regulating is done with the greatest facility. The dry steam produced by the boiler actuates a motor of two cylinders 2·25 inches in diameter in which slide pistons having a stroke of 3·5 inches. The speed on a good level road is from 10·5 to 12 miles an hour, 6 miles on gradients of 6 to 100, and from 3·5 to 4 miles on gradients of 13 to 100.

The carriage, boiler, heating arrangement, etc., are the work of an amateur, and we are pleased to recognize the merit and originality of them, although in principle the thermic rendering of a boiler heated with petroleum, and the steam of which supplies a motor, is very inferior to that of explosion motors.

It remains for us to speak of two carriages that reached Rouen late, owing to accidents on the way that are inevitable in experiments of this nature.

No. 7, which belongs to Mr. P. Gautier, reached Rouen in the evening. It is a two-seat gasoline carriage (Fig. 12) with a Daimler motor placed in front, as in the Panhard & Levassor vehicles, from which it differs, moreover, only in the details of carriage work and a few personal arrangements in the transmission of the motion of the motor to the hind wheels.

No. 18 likewise arrived late at Rouen. It is a steam omnibus for six passengers (Fig. 13) presented by Mr. E. Archdeacon, and designed for service between Pointe-a-Pitre and Moule. For the comfort and convenience of the passengers, the boiler, which is of the Serpollet system, is placed in the rear. It must be well understood that this vehicle, which is well elaborated for the service for which it is designed, in nowise answered to the programme.

From this succinct description, which is already lengthy, of the carriages that received prizes or that underwent the tests of the competition with more or less satisfaction, the conclusion clearly follows that the steam motor is indisputably inferior to the gasoline motor as a means of propulsion without danger; is easily manageable for the passengers, and does not cost too much upon the road. Without realizing the dream of the tourist or the commercial traveler, the gasoline carriage has entered into practice. The apparatus are improving every day, thanks to the lessons of experience, the minor inconveniences are disappearing, the mechanisms are becoming simplified, and the petroleum carriage will soon reach all the perfection of which it is susceptible. It would be temerity to see in it or to hope to find in it the automobile carriage of the future, but it has before it a vast field of applications happily improved by the competition of the Petit Journal.—E. Hospitalier, in La Nature.

SMOKE PREVENTION.

In its application to domestic ranges, this method consists in mixing the smoke as it leaves the flue with a small quantity of steam which is generated in a boiler forming part of the kitchen range. The blended steam and smoke pass into an open chamber, the upper part of which is provided with a number of pipes placed in the direction of the prevailing wind, and the air passing through these pipes helps to cool the gases. At the extreme top of this chamber, just before escaping into the atmosphere, the gases are met by a very fine shower of water issuing from minute holes in a pipe, and it is claimed that the result of this treatment is a very thorough washing of the smoke and the almost complete removal of all solid matters (soot and dust) and a large proportion of the sulphurous acid always present in coal smoke. The removal of the soot and dust is said to be so perfect that a piece of wet cotton, held in the issuing gases, remains perfectly white even after a lengthened exposure.

The amount of steam required is, we understand, so small that it need not be taken into account in an estimate of the cost of working the process, as it is generated by means of heat which would not otherwise be available for any useful purpose. The only item of cost to consider is that of water. The amount used in an apparatus fitted up for purposes of experiment was found to be, we are told, about 10 gallons per hour, including the condensed water from the steam. This apparatus was treating the smoke from a large kitchen range burning about 20 lb. of coal per hour, but from the results obtained, it was considered that it is capable of treating the smoke from several such fires. It is added that the draught was not sensibly impaired by the apparatus, any slight retarding of the flow of the gases being more than compensated by the action of the jet of steam.

Colonel Dulier's system has also been applied to the City Saw Mills, Glasgow, where it is at present in use, and we extract notes from the city analyst's report on its working, the following information:

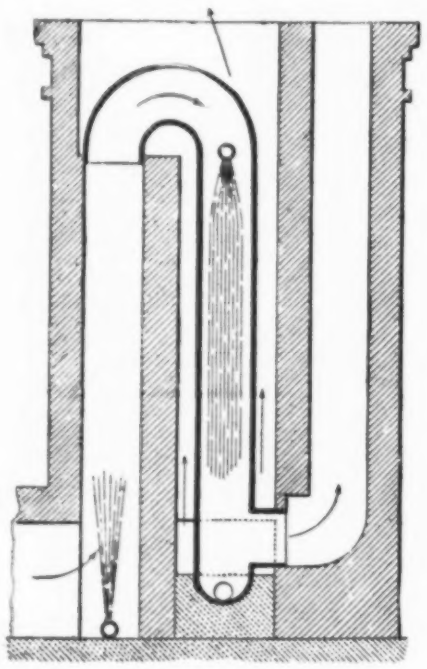
The boiler employed at these mills is of the Babcock & Wilcox water tube type, and the steam raised in it works an engine of 220 horse power, which necessitates constant firing and causes a dense and continuous smoke. The consumption of coal is about three tons per day, in addition to which half a ton of wood scraps and chips are burned for steam raising in the same boiler. The coal or dross employed gives the following analysis:

	Per cent.
Gas, tar, etc.	31·40
Fixed carbon	48·70
Sulphur	0·84
Ash	6·56
Water	12·50
	100·00
Coke	55·73

It may be noted here that the quantity of unconsumed carbon is found to be the most troublesome constituent of smoke, and its satisfactory combustion in the furnace, or before it escapes from the chimney, is the problem that has hitherto baffled the inventive ingenuity of engineer and scientist alike. How this problem is dealt with, according to Colone. Dulier's system, our extracts from the analyst's report will proceed to show.

The accompanying illustration shows the arrangement of his apparatus as fixed in the base of the shaft.

As the gases pass from the furnace they are assisted by a jet of steam in the flue of the apparatus, as already explained in the case of kitchen ranges. The



object of employing steam is to accelerate the condensation of the hydrocarbons and saturate the mineral dust with water vapor, to render them more liable to precipitation by the subsequent treatment. The gases pass through an ascending flue of masonry lined with fire bricks, and a descending flue built of steel plates dipped at a high temperature in a tar composition, the lower part being connected with a tank from which a drain carries off the water and residues. The gases are met at the top of the descending flue by a fine spray of water which is forced through a series of nozzles at a pressure of 100 lb., and by this means the soot and dust are precipitated.

The authority also states that, when properly erected, the apparatus does not interfere with the draught of the furnace, and that his tests of the proportions of sulphurous acid and soot and dust in the escaping gases show that the sulphurous acid is reduced by rather more than half the original quantity present, while the soot is removed to the extent of 94 to 97 per cent. These results, as he observes, show a high degree of efficiency obtained by a process which is at once simple and inexpensive.—Invention.

THE EVOLUTION OF A FLYING MACHINE.*

By Hiram T. Maxim.

In the summer of 1890, after a great deal of preparation, I conducted a series of experiments with a view of ascertaining definitely how much power would be required to perform artificial flight with an aeroplane driven by a screw. The apparatus which I used consisted principally of a long and rigid arm mounted on a central pivot and free to revolve around a circle 200 ft. in circumference. To the end of this arm was attached a small apparatus for carrying the screw and holding the aeroplane at any desired angle. Power was transmitted through the central pivot and long arm to the screw shaft. The dynamometers, tachometers, etc., were provided, so that it was possible for me to obtain with a great degree of nicety the exact thrust of the screws, the actual power required for driving them, the lift of the aeroplane, and the velocity at which the machine was traveling. About fifty different kinds of screws were experimented with, and aeroplanes of all sizes, from a few inches to 3 ft. in width, and with lengths varying from 2 ft. to 12 ft. were employed. Superposed planes were also tried. These experiments demonstrated that a well made screw was fairly efficient, that as much as 8 lb. per sq. ft. could be lifted with an aeroplane running 60 miles an hour, and that as much as 133 lb. could be carried with the expenditure of one horse power. Long and narrow aeroplanes slightly concave on the bottom side and convex on the top, driven edgewise and mounted at a slight angle, were found to be the best. Aeroplanes consisting of cambric tightly stretched on a frame were also tried, but I was only able to carry 40 lb. to the horse power, on account of the distortion that took place and the uneven character of the top side owing to the frame.

Having finished these experiments, it appeared to me that a flying machine was quite possible. I had already constructed two engines which I knew would develop 300 H. P., and which at that time weighed only 300 lb. each, or 2 lb. to the horse power. Very little was done in the development of a boiler and a proper flying machine until the autumn of 1891, on account of my absence from England. Early in 1892 I succeeded in making a boiler which operated exceedingly well, but I found it was a very difficult matter to make and burn the large quantity of gas that I required for my power without some danger of the flame blowing out or smoking. The character of my boiler demanded that the flame should not be of great intensity in any one spot, but that it should be evenly distributed throughout the entire firebox. At last I succeeded in making and burning all the gas necessary, using naphtha, which is a petroleum spirit immediately between gasoline and kerosene oil. The boiler and engines were placed on a platform constructed of steel tubes, and which was about 8 ft. wide and 40 ft. long, the engines being supported by brackets 18 ft. apart. To each of the engine shafts I attached wooden screws 17 ft. 10 in. diam. and with a mean pitch of 16 ft. These screws weigh 130 lb. each. I then prepared a railway, 9 ft. gauge and 1,800 ft. long, and upon taking the machine on to the track I found that the screws gave a very powerful thrust and that they were able to drive the machine along the track at a very high velocity.

I next mounted a very large aeroplane, 50 ft. wide and 47 ft. long (in a fore and aft direction), and placed it at an angle of about six degrees. The framework of this aeroplone was constructed of very thin and strong steel tubes and wires, and the bottom side was covered with tightly drawn balloon cloth. Upon again taking the machine on to the track, it was found that the lift did not greatly exceed the thrust of the screws. It was impossible to make the aeroplane so tight as not to bag; moreover, the framework on the top side offered a great deal of resistance to the air. My next step was to completely inclose the framework of the aeroplane, covering the top as well as the bottom side with balloon cloth. The top cloth was held down to the framework in lines in a fore and aft direction, and was allowed to bag upward between the holding-down bands. Holes were cut in the bottom cloth so as to allow the air to enter. In this manner the cloth on the bottom side of the aeroplane, having practically the same pressure on both sides, was not distorted in the least, the top cloth of the aeroplane taking all the load, and the bagging being in a fore and aft direction, did not offer a great deal of resistance to the air. Upon experimenting with this aeroplane it was found that with a screw thrust of only 700 lb. the machine traveled much faster and lifted a great deal more than it did with 1,000 lb. screw thrust with the original aeroplane. The last time the machine was run with this aeroplane it lifted the front wheels of the machine completely off the track and a large amount of the weight off the hind wheels. In falling, one of the front wheels missed the track, and, sinking into the ground, the machine was tilted to one side and was tipped over by a sudden gust of wind, the aeroplane being completely destroyed.

The next aeroplane which I constructed was also 50 ft. wide, but much smaller than the old one in a fore and aft direction, and it was made very sharp and thin at the edges, and set at a slightly greater angle. When this was finished it was found that it could be run over the track at a very high speed, and that it offered very much less resistance to the air than the former one. Its lifting power was also greater in proportion to its area.

The central aeroplane having proved completely satisfactory, I provided some long and narrow aeroplanes which could be attached to each side of the machine, the machine being so constructed as to carry five on each side. The top ones were attached directly to the sides of the main aeroplane. They were 27 ft. long, which brought the compiete width of the machine up to 104 ft. The bottom pair of aeroplanes was attached to the framework about 5 ft. from the ground, both being tilted upward so as to prevent the machine from rolling.

Fore and aft rudders for steering the machine in a vertical direction were then put in position and the machine run over the track at a moderate speed, and it was found by tilting the rudders that a portion of the weight could be shifted from the front to the rear axletree, and vice versa, as desired. I determined to run with these four aeroplanes and see what they would do before I placed any others between them. With these aeroplanes and rudders in position, with three men on the machine, with 600 lb. of water in the tank and boiler and 300 lb. of naphtha on board, and with the auxiliary wheels and their attachments for running on the top safety track, the machine weighed very nearly 8,000 lb. This great weight completely closed the springs interposed between the hind axletree and the body of the machine, so that the dynagraphs, which had been made to record only up to 6,000 lb., failed to record the full amount of lift. The aeroplanes had to lift nearly 2,000 lb. before the dynagraphs would commence to work properly. The first run was with 150 lb. of steam per sq. in., and the recorded lift was 2,700 lb. The second run was made with 240 lb. of steam and the recorded lift was 4,700 lb., which, with the correction due to the excessive load, would

* Paper read before the Mechanical Science Section of the British Association at Oxford by Hiram T. Maxim, August 10, 1894.

bring the lift nearly up to the whole weight of the machine.

Before the third and last run was made I readjusted the rudders, as I found that the rear one had been set at such an angle that it interfered with the delivery of the air from the screws; and I believed, notwithstanding that this rudder was lifting a very heavy load, that the total lift of all the aeroplanes would be greater if the angle of this rudder was changed. Everything was got in readiness; careful observers were stationed along the track and the machine tied up to a dynamometer.

The engines were then started and the pump set so as to deliver over 5,000 lb. of water per hour into the boiler. The gas was then carefully turned on until the pressure mounted to 310 lb. per sq. in., and the screws showed a thrust on the dynamometer of more than 2,100 lb. I had placed a small safety valve in the steam pipe which had been carefully adjusted so as to blow off slightly at 310 lb. and a strong blast at 320 lb. At the time of starting, this safety valve puffed slightly at each stroke of the engine. The signal was given to let go, and the machine darted forward at a terrific pace, the speed of the screws increasing. More steam being consumed, the safety valve ceased to blow. I instantly turned on more gas, and before the machine had advanced 300 feet the steam had mounted to 320 lb. per sq. in., and the safety valve was blowing off a steady blast. One of the assistants on the machine had instructions to watch the gauges and note the pressure, while the other had instructions to watch the upper wheels, which were for the purpose of keeping the machine from lifting off the track.

It should be understood that there are two systems of track, one an ordinary light steel rail 9 ft. gauge, and an upper or safety track of about 30 ft. gauge placed at a suitable height to engage four small wheels placed on outriggers on both sides of the machine. When the machine had traveled only a few hundred feet, all four of these wheels, as observed by myself and my assistants, were fully engaged, which showed that the machine was lifting at least 8,000 lb. The speed rapidly increased until finally, when the machine had run about 900 feet, the rear axletrees, which were of 2 in. steel tubing, doubled up and set the rear end of the machine completely free. This allowed the machine to lift still farther, and the pencils run completely across the paper on the cylinders of the dynagraphs and caught on the lower end of the cylinder. When the machine had traveled about 1,000 feet, the rear end was tilted upward to such an extent as to considerably alter the angle, not only of the aeroplane, but also of the platform on which I stood, when suddenly the left hand forward wheel became disengaged from the safety track, and shortly after this the right hand wheel broke the upper track—3 in. by 9 in. Georgia pine—and the plank became entangled in the framework of the machine. Steam had already been shut off and the machine was brought to a state of rest and fell directly to the ground, all four of its wheels sinking deeply into the turf without leaving other marks. Before making this run the wheels which were to engage the upper track were painted, and the paint left by them on the upper track indicates the exact point where the machine lifted.

As this is the first flying machine which has ever been made in the world which will actually lift itself, its motive power, its fuel and water and its engineers, a few particulars in regard to the boiler, the engines and other machinery will perhaps be interesting. The boiler consists for the most part of copper tubes ⅜ in. in diameter and $\frac{1}{16}$ in. thick. Its construction is similar to that employed in some torpedo boats, except that the tubes are much longer for their diameter and very much thinner and have more bends in them. The boiler proper weighs 670 lb. Just above the boiler is placed a feed water heater consisting of a network of very fine copper tubes.

This greatly reduces the temperature of the escaping products of combustion and prevents the dome and smokestack of the boiler from becoming overheated. The boiler with its casing, smokestack, feed water heater and so forth, and seating, weighs 909 lb. and the gas burner 100 lb.

The engines are compound. The area of the high pressure piston is 20 sq. in. and that of the low pressure piston is 50·26 sq. in. Both have a stroke of 12 in. With a boiler pressure of 320 lb. the pressure on the L. P. piston is 125 lb. to the sq. in. This abnormally high pressure in the L. P. cylinder is due to the fact that there is a very large amount of clearance in the H. P. cylinder to prevent damage in case water should go over when the machine pitches; moreover, the steam in the H. P. cylinder is cut off at three-quarter stroke, while the steam in the L. P. cylinder is cut off at five-eighths stroke. If we compute the power of these engines with the steam entering at full stroke without any friction or back pressure on the L. P. cylinder, the total H. P. would foot up to 461·36 H. P. at the speed at which the engines run, namely, 375 turns per minute. If we compute the actual power consumed by the screws by multiplying their thrust, which is probably 2,000 lb. while they are traveling, by their pitch, 16 ft., and this by the number of turns which they make in a minute, and then divide the product by 33,000 $\frac{2{,}000 \times 16 \times 375}{33{,}000} = 363{\cdot}63$, we find that we have 363·63 H. P. in actual effect delivered on the screws of the machine, which shows that there is rather less than 22 per cent. loss in the engines, due to cutting off before the end of the stroke, to back pressure, and to friction. The actual power applied to the machine being 363·63 H. P., it is interesting to find out what becomes of it. When the machine has has advanced forty miles (which it would do in an hour) the screws have traveled through a distance of 68·1 miles $\frac{375 \times 16 \times 60}{5{,}280} = 68{\cdot}1$; therefore 150 H. P. is wasted in slip and 213·63 H. P. in driving the machine through the air. Now as the planes are set at an angle of 1 in 8, the power actually used in lifting the machine is 133·33, and the loss in driving the body of the machine, its framework and wires through the air is 80·30 H. P.

The area of the aeroplanes is very nearly 4,000 sq. ft. and the total amount lifte l was fully 13,000 lb. The planes therefore lifted 2·5 lb. per sq. ft., and 5 lb. for each pound of thrust. It will be observed that the greater part of the power lost is in the screw slip. This shows that the diameter of the screws is not great enough; instead of being 17 ft. 10 in. diameter, they should have been at least 22 ft. diameter. I find that the framework could also be modified so as to reduce the loss in this direction from 80 to 30 H. P. These alterations would admit of the cylinders being made with a longer stroke, would increase the thrust and also the speed, which would again admit of placing the aeroplanes at a much less angle. With these alterations the surplus lifting power of the machine would probably be increased, so that perhaps 5,000 lb. of fuel and water could be carried.

My experiments have shown that an efficient atmospheric condenser can be made very light. The condensing surface may be made in the form of small aeroplanes, and a large number of these can be superposed in a rack. The air in passing through them not only condenses all the steam, but at the same time exerts a lifting force which is considerably superior to the weight of the condenser; so I believe that a large machine might be made in which the waste of water would not exceed 20 lb. per hour; and I also believe that the engines might be made sufficiently economical so that one pound of naphtha, which is equal to 2 lb. of coal, might produce 1 H. P. per hour.

Therefore, if a machine were running at 300 H. P., it would require 300 lb. of naphtha per hour, so with 4,000 lb. of naphtha the machine would be able to keep in the air 13·33 hours, which, with a speed of 50 miles an hour, would be 666·5 miles, or, say, 300 miles and return, with a fair margin of safety. Now that a machine has actually been made strong enough to lift its own weight in the air with a considerable margin to spare, the question of steering is the next problem to attack, and this can only be safely carried out in a large and level field completely free from trees and houses. Experiments should be commenced by running within a few feet of the ground, and no attempts should be made at flying long distances until the machine can be made to travel perfectly within 4 or 5 ft. of the ground in any direction, and not until after the steersman is able to turn the machine in any direction at will, to elevate it say from 8 to 10 ft., and come down again without touching the earth, should high or long distance flight be attempted.

Many people are of the opinion that when flying machines become perfected they may be employed to carry freight and passengers and that private individuals may use them as they now do carriages and boats. I, however, am not of the opinion that they can be profitably used for these purposes, because they are expensive to make and their navigation will be beset by a considerable degree of danger, about the same as ballooning is at the present time; moreover, every man who navigates a flying machine should be not only an experienced engineer but also an acrobat. The use of a flying machine, like that of torpedo boats, will be for the arts of war, and not for the arts of peace. As an instrument of warfare they will be altogether superior to anything which has yet been invented. A great many of them could be built for the price of a man-of-war and one of them could do infinitely more damage than twenty of the largest ironclads. A few of these machines would enable England to effectively assault France or France to assault England in spite of all the ironclads that the channel could hold. Machines with 1,000 horse power or more might possibly be made to travel more than 1,000 miles with the fuel they would be able to carry.

The advantages arising from driving the aeroplanes on to new air, the inertia of which has not been disturbed, is clearly shown in these experiments. The lifting effort of the planes was 2·5 lb. per sq. ft. A plane loaded at this rate will fall through the air with a velocity of 22·36 miles per hour, according to the formula $\sqrt{200\ P} = V$. But as the planes were set at an angle of 1 in 8 and as the machine traveled 40 miles an hour, the planes only pressed the air downward 5 miles an hour $\left(\frac{40}{8} = 5\right)$ A fall of five miles an hour without advancing would only exert a pressure of 0·125 lb. per sq. ft. according to the formula $V^2 \times 0{\cdot}005 = P$.

With aeroplanes of one-half the width of those I employed and with a velocity twice as great, the angle could be much less, when the advantages of continually running on to fresh air would be still more manifest. With a screw thrust of 2,000 lb. the air pressure on each square foot of the projected area of the screw blades is 21·3 lb. while the pressure on the entire disk of the screws is 4 lb. per sq. ft., which would seem to show with screws of this size that four blades would be more efficient than two.

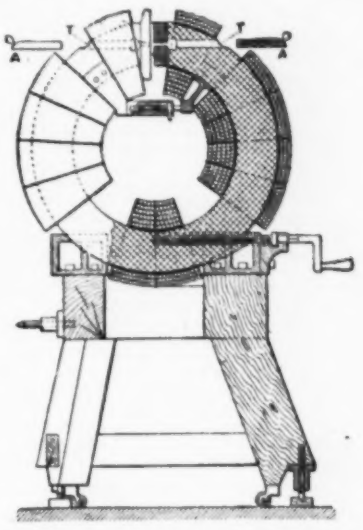
A RING ELECTRO-MAGNET FOR PRODUCING INTENSE FIELDS.

THE apparatus, by H. Du Bois, consists of a ring of annealed soft iron of a mean diameter of 50 cm. There are 12 coils, each of 300 turns and embracing each a sector of 20°. They have a total resistance in series of 2·4 ohms, and are capable of carrying a current of 45 amperes, 108 volts. The magneto-motive force is thus 108,000 ampere turns, and the mean intensity of the field 860 C.G.S. units. 380 C.G.S. units go to produce the induction, and the remainder is used in resisting the demagnetizing action; the intensity of magnetization is 1,600 C.G.S. The maximum value of the coefficient of self-induction is 180 henrys, and the current takes an appreciable time to attain its definite value; for example, a current of 1 ampere only arrives at $\frac{1}{10}$ of this value in about 17 seconds. Hence it is necessary to make and break current very gradually. A general view of the apparatus is shown in the figure.

The measurement of the magnetic field between the poles (which can attain 38,000 C.G.S. units) is effected by the means of the method of the rotation of the plane of polarization in water which can be placed in this space. A canal, T, perpendicular to the pole piece, permits of these measurements being made very easily. In most experiments, however, this canal would be stopped up by the rods, A, A. The dispersion of the lines of force increases with the intensity of the current, passes its maximum at about 3 amperes, and then diminishes.

Very intense fields can be obtained, as every one knows, by concentrating the lines of force by means of conical pole pieces, for which theory indicates as the most favorable summit-angle 109°, but in reality the best results are got with a summit angle of about 120°, as Ewing and Low have already proved. This is the angle selected by Du Bois for his pole piece summits.

So far the apparatus has only been used for measuring the "Verdet constant" for a certain number of samples of glass of which the indices of refraction were known. Further details may be found by consulting Wiedemann's Annalen, LI., p. 537.



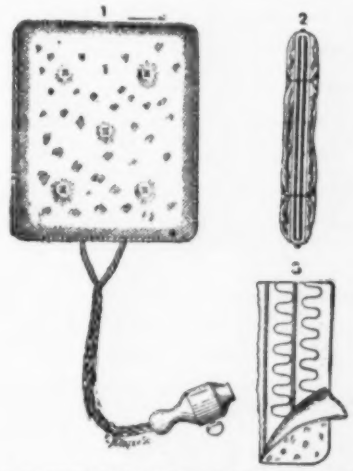
AN ELECTRO-THERMOGENIC MATTRESS.

IN speaking of the possible applications of the heat disengaged by the passage of currents, we once took occasion to describe in these pages a mattress and a blanket for invalids.

The mattress is now manufactured by Mr. Samuel Nutting, and the accompanying figure represents it. It is an ordinary mattress whose interior is provided with two plates of asbestos between which are arranged several German silver wires in zigzag form for distributing the heat and that do not have to contend with the dilatations. These wires are naturally separated from one another and are kept in place by asbestos cords. The circuit is terminated by a flexible wire and a current collector that may be branched upon a general system of electric distribution and put into or out of circuit at will through an ordinary interrupter placed within reach of the hand of the invalid or his or her nurse.

We have here an interesting application of a nature to increase the utilization of the current of central stations, and we should not be surprised if next winter some rich Sybarite, of whom there are so many in large cities, puts to profit this little apparatus of domestic economy for heating his bed and preserving a gentle and agreeable heat for himself.

This, moreover, is not the sole application that can be anticipated for the electric heating of the future. At a recent session of the Royal Society of London, another inventor exhibited an "electric cataplasm" heated by an analogous process and designed to replace flaxseed meal, the disagreeable aspect and frequent changing of which constitute well known inconveniences. The permanent communication necessary between the electric poultice and the central station, by means of a flexible conductor, is a restraint without importance during the night and when the invalid is confined to his room. These are unexpected for applications and that could not be foreseen. The future certainly holds many others in reserve for us.—La Nature.



ELECTRO-THERMOGENIC MATTRESS.

1. General view. 2 Section. 3. Arrangement of the German silver wires.

UNDERGROUND London is many stories deep. The new City and Waterloo underground electric railway, in traversing Queen Victoria street, passes for a considerable distance underneath the low level sewer, which runs beneath the underground railroad. The electric road at this point is 63 feet below the surface.

ELECTRICAL PHENOMENA ILLUSTRATED BY APPLIED HYDRAULICS.

The teacher is often put to his wits' ends for comparisons with which to illustrate to the student some complicated or strange phenomenon. The movements of water are often used to illustrate some few of the first principles of electrical conditions, but the following, which is the work of G. Claude, is far more thorough and complete in this direction than anything preceding it, and will certainly enable the student to better understand and the tutor to explain many electrical phenomena.

For instance, nothing is more readily seen than that a current of water, other things being equal, will flow more rapidly with an increase of head, but with a current of electricity we see nothing except the effects produced, as in the increase of illumination in an incandescent filament with an increase of potential, and the mind is not always satisfied with mere results. Our philosophical natures demand something more.

But if we remember that this incandescence corresponds to the disengagement of heat occasioned by the friction of a liquid in a tube; that this increase of incandescence may be compared to the increased friction due to a more rapid movement of the flowing mass (the equivalent of an increased head), and if we do a little reasoning on causes and effects in the case, we will assist the electric current to materialize before our mental vision, and the comprehension of its divers properties will become more clear to us. The expression "current," as applied to electricity, is a wonderful aid in illustrating and comprehending the phenomena.

Now, while it is not possible that perfect analogies exist between hydraulic and electrical action, there is still enough similarity to render the study not only interesting, but instructive.

I.—CONTINUOUS CURRENT.

A vase, A, Fig. 1, is placed at a certain height, h, above another, B, with which it is connected by a

Fig. 1.—CONTINUOUS CURRENT—RESISTANCE.

tube. B is assumed to have a surface sufficiently large to contain the flow through T without sensibly increasing its level, while A is furnished with a supply which maintains its level despite its losses by escape through T, and we have the analogy of battery or other source of electromotive force.

For a given length and cross section of tube the flow of liquid will be dependent on the friction, that is, on the polish of the interior of the conductor; the nature of the interior, then, to an extent is comparable to the nature of an electrical conductor. It is evident also that this resistance opposed to the flow of the liquid will be increased with a lessening of the cross section, and with added length. The similarity to electrical resistance is quite perfect. The difference of height corresponds to difference in potential, and the analogue of intensity will be the weight of the liquid flow into the time consumed.

Self-induction.—Suppose now we suddenly open the cock, R, permitting the liquid a free path between A and B. The liquid will not move instantaneously, because of its inertia, which must be gradually overcome, as if there were an augmentation of the resistance in the tube; and reciprocally, when the liquid has assumed its movement, we cannot instantaneously stop the flow, because of a certain reaction which is simply the restitution of the energy absorbed while putting it in motion. We see here the influence of inertia in the liquid opposing its movement in the first instance and opposing the cessation of motion in the second—analogies of the action of the self-induced currents in their opposition to the direct current flow.

A second illustration of this action is found in the succeeding experiment. In this the element of friction is left entirely out of the question. From this we can draw some interesting conclusions; once the fluid is set in motion the flow is established and the movement is uniform and constant in both rate and quantity, exactly as if there were no inertia. The interference of this disturber is limited to the moments of the establishment and the cessation of the flow. By analogy we see that in an electric circuit in effect the same phenomena is present—during the flow of current self-induction is not apparent through its retarding quality.

We will place before the stopcock, R, a tube, t, open at the upper extremity, Fig. 2. Now suddenly close R.

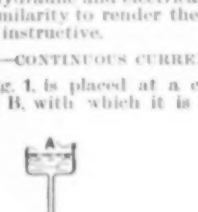


Fig. 2.—SELF-INDUCTION—EXTRA CURRENT.

All the energy stored up during the putting in motion of the liquid in T, being forced to expend itself at a single effort, but not being constrained to expend its energy in the form of reaction against the walls of the tube, T, because there is another road of an easier character, an overflow occurs through t, which rises to a greater height than the source, A, and the more suddenly the cock, R, is closed the more violent will be this fountain action. In the same manner, and for the same reason, the extra current spark rises to a potential higher than the source which gives it birth.

Finally, no matter how thin or how long a conducting tube may be, a certain retardation is ever present, and the same is true of a wire or other electrical conductor, even in rectilinear lines, with but few exceptions.

Capacity.—We will now consider this element. When we desire to represent capacity we compare it, sometimes to a vase, B, Fig. 3, partially filled with a

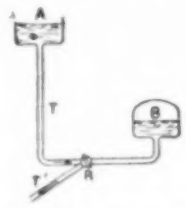


Fig. 3.—CAPACITY—FIRST CONDITION.

gas of which the compression proportional to a difference of level of the lower receptacle—or perhaps better, the different levels, A and B—will represent a counter electromotive force; or again, a vase, B, in which there is a certain elasticity in the walls, the tension of these will then illustrate the force equally well as gaseous elasticity. We will adopt the first illustration, as in Fig. 3.

The difference in level will be shown by the compression of the gas in B, because of the initial pressure of the column, A T, and the entrance of a portion of liquid forced against B. There is in T a charging current, which is gradually less until the two forces, the electromotive force and the counter electromotive force, balance, when the current becomes nil.

We also see that now the quantity of liquid flowed into B expends no power, but is pent up or stored until when the pressure or tension is removed, there will be a return movement of the liquid through the elasticity of the gas—a discharge current. This action is quite analogous to the action of a condenser put in action by a constant current; a charging current at first intense, but rapidly diminishing in pressure as the counter pressure increases, until an equilibrium is attained; and now, on removing the charging current, we may discharge the electrical magazine (the stored up current), which has become an electromotive force direct instead of a counter electromotive force, either in the form of heat through a conductor of proper thickness or in the form of a spark.

But again, other circumstances are not fully in accord with ideas which are commonly advocated, and this illustration has been adopted to show the fallacy which is so commonly repeated as to the charge of a condenser and to which it corresponds precisely. Thus, if we admit this method of representing the idea of capacity, we are forced to admit the oft-committed error that the charge of the condenser is created by an afflux from the source of electricity to the condenser through an accumulation analogous to an accumulation of matter. In other words, if we wish to represent in this hypothesis the equivalent of several condensers in tension with a common difference of potential, or again, a condenser in derivation on a conductor, this representation would be impossible; in the latter case, for example, we will have a condition like that in Fig. 4; that is to say, that the differ-

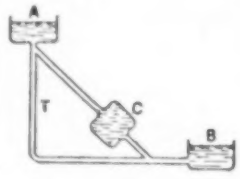


Fig. 4.—CONDENSER IN DERIVATION—FIRST CONDITION.

ence of level, after having accomplished the expansion of C, continues to send by the same route a permanent flow of liquid, which evidently does not fit the condition of the condenser.

For these reasons we are constrained to seek a primitive representation of capacity, a new representation which will be more perfectly in accord with the facts. A vase, C, Fig. 5, open at its two extremities and per-

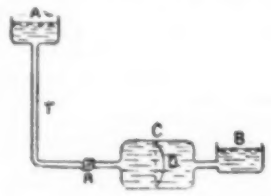


Fig. 5.—CAPACITY—SECOND CONDITION.

fectly full of liquid, shows at its center an elastic diaphragm, D, which completely obstructs the flow. Now if we connect this system with a source, A, higher than the vase, C, the diaphragm will be forced out of the perpendicular, and the fluid will consequently rise in B. We see the charge is represented in this illustration by a current analogous to that which traverses an ordinary conductor, and which we do not now compare to an accumulation of matter, because the liquid in B remains the same in quantity before and after the charge, and has simply been displaced. What has varied during the charge is only the tension of the membrane. The energy developed has simply augmented the tension, and reciprocally during discharge it will be this membrane which, returning to its normal condition, returns the bound energy. It is the diaphragm, then, which in the charge plays the principal role. It should be the same in the condenser, if our comparison is exact, for the dielectric is the equivalent of the membrane. The experiments with Leyden jars having removable armatures show unequivocally that the charge resides in the dielectric, and not in the electrode, and we know that as a sufficiently elevated source of supply of fluid will break down the elastic membrane, D, so will a sufficiently high potential difference pierce the dielectric.

We may then conclude that the charge of the condenser is rather an accumulation of energy than of quantity; that this accumulation is obtained by a modification of the molecular condition of the dielectric, produced by the passage of the charging current, which serves simply as a vehicle to the energy necessary to accomplish this modification. The law, $W = \frac{1}{2} Q E$, will signify, then, that the pent up or bound energy in a condenser is equal to one-half the product of the electromotive force into the quantity which has been displaced, and not the quantity held by the condenser. Such is, simply stated, the material representation of Maxwell's ideas on this subject.

Nothing is easier now than to represent a battery of several condensers in tension or series, Fig. 6, where the

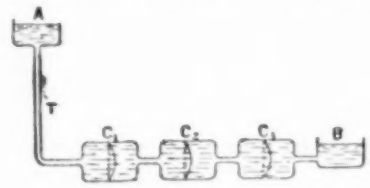


Fig. 6.—CONDENSERS IN SERIES.

same electromotive force charges all simultaneously, and of which their counter electromotive force is aggregated to equalize the direct current flow of a condenser in derivation on a conductor, Fig. 7.

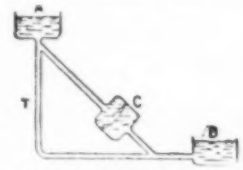


Fig. 7.—CONDENSER IN DERIVATION.

Accumulators.—With some complications required by the necessities of the case, we may represent electrical accumulators in a manner identical with condensers, although they set up two different actions, like condensers of very large capacity. We are forced to the conclusion in this case that, like the condenser, the accumulator does not represent the storing up of a quantity of electricity, as is expressed when we say that the accumulator stores up so many ampere hours, but has stored up an amount of energy of which the charging current has simply been the vehicle.

Only in place of a molecular change in the dielectric of the condenser, it takes the form of dissociation of the chemical elements of the electrolyte, which, after all, is again but a change of molecular condition.

II.—VARIABLE CURRENT.

Electrical Oscillations.—Before leaving this branch of the subject let us attempt to represent by hydrodynamic analogy one of the most curious electrical phenomena, the oscillating discharges of condensers.

We have understood up to the present that in the charging of the receptacle in Fig. 5, under the pressure exercised by the superior level of A, the inertia of the liquid circulating through the tube, T, was negligible, because of this being short and of small cross section. Suppose now that we take a tube of greater cross section, Fig. 8, and establish the communication between

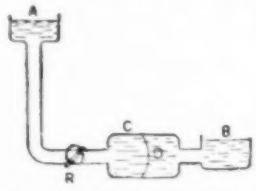


Fig. 8.—OSCILLATIONS.

A and C, by the aid of the stopcock, R. The liquid will pass from A to C, forcing the diaphragm toward B, increasing this strain until an equilibrium is formed between A and C, but at this moment the liquid in the tube, having a high rate of speed from A toward C, will not come to rest instantaneously. By virtue of its inertia and its acquired motion it continues to press upon the diaphragm, destroying the equilibrium. When this movement ceases to overbalance the tension of the opposing force (the elasticity of the membrane) a reaction takes place and the fluid is forced past the balancing point in the opposite direction, to be again surged against the diaphragm. These movements will gradually become weaker at each successive change of direction until quiet is restored.

It is proper to remark that in these oscillations there is always the same quantity of energy called into play, which prolongs the movement of liquid from A to C, and the reverse. This quantity of energy is borrowed from the source under the form of quantity of movement; it is the quantity of movement which, when we open R, was bound in the liquid up to the instant when perfect equilibrium was accomplished.

Such is the explanation of the phenomena of oscillations which in electricity, by combining the effects of capacity and self-induction, produce such curious effects. The only difference between the two is in the rapidity of the oscillations—in the one case but few per second; in the other, millions.

Special dispositions are necessary to realize the act

corresponding to the opening of the cock, R. If this is slowly opened we know that the oscillations will not be produced with the same perfection. In the same way in a circuit where the oscillations are extremely rapid these do not manifest themselves by the simple movement of a commutator, but to excite them we have recourse to the phenomenon of the disruptive spark, which is the equivalent of an instantaneous movement of the stopcock, R.

The preceding example shows with what precision hydraulic analogy seizes the most complex phenomena. If, for example, the diaphragm is very large, its counter pressure increases slowly and the oscillations are proportionably moderate, while presenting a greater amplitude. It is the same if the mass is considerable, for this mass moving in a given direction may stop quickly; on the contrary, when the resistance is considerable, it intervenes to dissipate the quantity of movement at the same time that the diaphragm absorbs it, resulting in diminishing the amplitude of the oscillations, rapidly deadening them, while increasing their rate of movement. All these results have their analogies in electric circuits.

III.—ALTERNATE CURRENT.

In studying the alternate current, we must first represent an alternate electromotive force. To do this we are led to employ a vase, A, Fig. 9, filled with liquid

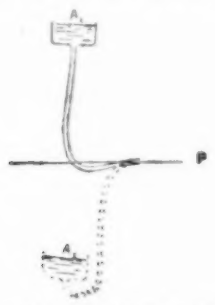


FIG. 9.—ALTERNATE CURRENT.

moving alternately up and down past the center horizontal, P, which we will consider as the origin of the differences of head or level, and call positive the situation when A is above and negative when it is below the zero line. If we wish to show both difference of level and another characteristic of the current, we have only to suspend A to a spring the length of which will be governed by the periodic time we desire to obtain.

Alternate Electromotive Force Acting Against a Resistance Without Self-induction.—Let us examine first a case where the vase, A, is connected to another open vase, B, Fig. 10, of which the level corresponds to the

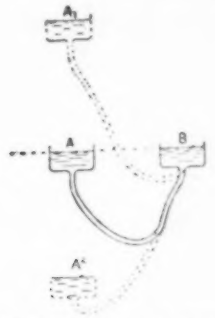


FIG. 10.—RESISTANCE TO ALTERNATE CURRENT.

plane, P, by a flexible tube of little length and small cross section. This tube, according to the preceding considerations, corresponds to a conductor presenting great resistance and little self-induction, and we may, to simplify the conditions, entirely ignore the inertia.

Suppose that A and B being normally at rest have the same level, and we raise the vase, A. The liquid is at once set in motion from A toward B, its intensity increasing as the difference of level increases. Assuming that there is no inertia, the current has at each instant precisely the value it would have if the difference of head were to remain constant at that point. The maximum of intensity of current, then, will necessarily correspond to the point, A, when the vase has reached its uppermost limit, and reciprocally the current will diminish with the reverse movement, until, passing the center or zero line, P, it attains a negative maximum at A_2.

Now, neglecting inertia as a factor, we have the difference in level and that of intensity of the current synchronous with the phase. Further, immediately we make a change of movement, the liquid at once conforms to the new order of movement.

The case corresponds to that of an alternate electromotive force acting upon a resistance without self-induction, and we may conclude that in this case the intensity of the current is in sympathy of phase with the electromotive force acting on a resistance without self-induction, and we are safe in assuming that the intensity of the current is in accord of phase, with the electromotive force (having an instantaneous value, It) equal to the instantaneous value of the electromotive force, Et, into the ohmic, R, of the circuit, and that finally, when we place this resistance against the electromotive force, the current immediately assumes its normal value without passing through a variable period to reach that condition.

Electromotive Force Acting upon a Circuit Presenting Resistance and Self induction.—We will now introduce the inertia which we have not been able to eliminate except theoretically. Suppose we have the tube connecting A and B both large and long. Raise A, Fig. 11. By virtue of its inertia, the movement of the liquid does not precisely follow the ascensional movement of A; if we consider a position during the upward movement, say A_3, the liquid has not yet had time to acquire the speed which should correspond to this position were it stationary—that is, there is a retarding influence which will be greater in proportion to the rapidity of the upward movement.

The higher the point of comparison, the more marked will the retardation appear, as at A_3, A_4, and A_5. A

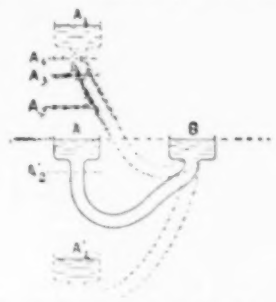


FIG. 11.—SELF-INDUCTION IN ALTERNATE CURRENT.

reversal of the movement now will show that while the head is being lowered down to a certain point, say A_2, there is no diminution in the flow of current, but below this point the current will diminish, so that a point somewhere between A_2 and A_1, which we have assumed to be A_2, will correspond to a fixed maximum, which would produce the current at the moment. From this moment the current will no longer diminish, so that A_1 corresponds to the maximum of the current, and this maximum, in place of increasing with the difference of head, will decrease.

Now, the vase continuing to descend arrives at A. At this moment the liquid is again rapidly moved from A toward B, because up to this point there was a positive difference of level. By virtue of its inertia it still flows from A to B, and the movement is not checked until after the level, B, is passed.

In the second part of the cycle matters do not pass exactly in the same manner as in the first half, because the current, in place of being nil at A, as in the first instance, is not quieted until after the movement below the level is commenced. We can see that through this retardation at the point, A_3, for instance, there is an intensity more feeble in absolute value than at the corresponding distance above the line at A_3 in the ascending movement; in other words, the retard movement of the current is increased. This increased retardation will continue during several oscillations until uniform and perfect periods are accomplished.

We may, then, conclude from the foregoing that when inertia intervenes: first, intensity, instead of having at any time a value determined by such a change of level, really has a very small value. Inertia seems, then, to augment the resistance opposed to the passage of the liquid, increasing this with an increase of mass, and this not only during the short period of establishing the flow, but, as we have seen, when it is put in action by a constant difference of level permanently. It should be remarked, however, that this is only an apparent augmentation of the resistance. Second, the current is always retarded by a difference of level. There is between these a certain difference of phase. Third, the establishment of the normal condition is not instantaneous. It is preceded by a variable period of an oscillating character.

Alternate Electromotive Force in a Circuit Having Both Resistance and Capacity.—Remembering the representation of the condenser in a former instance, we will assume that C, Fig. 12, is connected to A by a

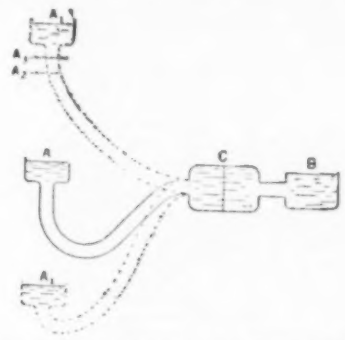


FIG. 12.—CAPACITY OF ALTERNATE CURRENT.

tube quite short, large and flexible, in which we will assume for the present there is no resistance to the passage of the liquid and no inertia. The two vases being at repose, we raise A. A current from A toward C is set up, and there is a progressive tension on the membrane, which is almost precisely proportioned to the difference of level, and the excess of pressure of A over the counter-force of C is always quite feeble, and as it is this excess which determines the current, this latter cannot at any time acquire a very considerable value. When A has arrived nearly at the upper position of its route, its movements are slower, as is also the current in T, and at the summit, A_1, where the speed becomes nil, equilibrium is established between the tension and the difference of level and the flow ceases. In this case, which is only theoretical, the current is annulled at the instant when the difference of level is a maximum.

Now, lowering the vase, the counter pressure due to the tension of the membrane tends to counteract the direct pressure, and when very near its level the current changes sign and flows from C toward A. This flow continues, rapidly increasing, until by the time the membrane has assumed its normal position the vase has passed the center, and the current has gained an advance of the electromotive force a quarter of a period, which, we shall find by following the movements of the vase, A, will persist indefinitely.

Theoretically this is correct, and it is in this sense more easy of comprehension. If, however, instead of a very large tube we substitute a very fine one, the movements of the diaphragm will be, of course, much more sluggish, both on the rise and fall of the vase, A.

From the foregoing we see that:

First.—When a condenser is placed in series with a resistance against an alternate electromotive force the circuit is the seat of alternate current; the condenser, in place of presenting an infinite resistance, as with a direct electromotive force, presents continuously a relatively feeble resistance, which diminishes as the capacity and frequency are increased.

Second.—The simultaneousness between the maxima and extinction of the electromotive force and the intensity which exists with a perfect resistance in circuit does not exist when a condenser is placed in series with the resistance. The intensity is then in advance of the electromotive force, and this lead or advance being greater in proportion to the frequency, the resistance and the capacity are correspondingly less, within a limit of one-quarter of a period.

Third.—When we place a condenser and a resistance in series with an alternate electromotive force, the current does not immediately take up its normal movement, but requires time to establish itself.

Alternate Electromotive Force in a Circuit Comprising Resistance, Self-induction and Capacity in Series.—Resonance.—Connect A by a long tube of large section to the diaphragmed vase, C, Fig. 13, thus rendering the

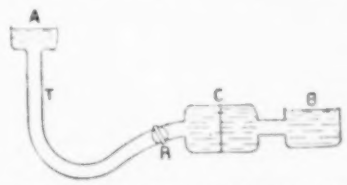


FIG. 13.—SELF-INDUCTION AND CAPACITY IN SERIES, RESONANCE.

inertia considerable and the friction comparatively negligible. If we suppose for an instant that A is placed in a permanent position, and if we suddenly open the communication at the cock, R, we know that this will establish an oscillatory movement of current in the tube, T; that the periodic time of these oscillations is determined by the fundamental vibratory rate of the system (capacity of C, mass of liquid, amount of friction, etc.), but is independent of the difference of level, just as the longer and shorter oscillations of a pendulum are isochronous. In other words, the period of oscillation is, in a manner, a characteristic of the system, A T C.

Now, substituting a variable position for A with a uniform period for its excursions, those oscillations which are proper to the system will tend constantly to superpose themselves on the resulting movement of the liquid.

If the movement of A is uniform in its beats, and if its period is something near the oscillations spoken of above, the vibrations of the liquid will gradually fall into concord with the system; just as a person in a swing will gradually by alternately changing his center of gravity arrive at a point when the opposing forces will just balance the effort and the vibration will remain constant. But suppose these opposing forces are nil; that is to say, that the resistance opposing the flow in T is nil, and the elasticity of the diaphragm is perfect. The oscillations will then increase in amplitude up to the highest limit, just as the swinger after reaching a certain amplitude must cease effort or incur a threatening danger.

Alternate Electromotive Force Acting in a Circuit Having Self-induction and Capacity in Derivation.—The hydrodynamic representation of this case, Fig. 14,

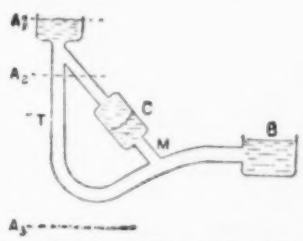


FIG. 14.—SELF-INDUCTION AND CAPACITY IN DERIVATION.

assumes that the inertia of the branch, C, is negligible. We endeavor to seek the value of the current below the junction, M.

This case is more simple than the preceding, for each branch may be considered singly, and it then remains to determine the result of the two movements.

According to a former hypothesis, when, after a certain number of oscillations of A tending to establish a uniform rate of vibration, the vase, A, is at the upper limit of its movement, the current in T is nil, and the current in C also, but the compression of the diaphragm is at its maximum, the current of liquid below M is also equally motionless. Now A commences to descend, the liquid in T is put in motion from A toward B. But now the elasticity of the diaphragm, C, produces an upward current which opposes the movement in T. The current then below the junction will be the difference between these two. If T is greater, the current will flow toward B, and will be positive, but if C preponderates, then the resulting current will be negative. Finally there will come a point at which the two will be equal. Now all the liquid which flows through T toward B will be drawn up by C, and the resulting current will be nil, and if this relation between the conditions at C and T be represented by a position (A_3) of the vase, we can con-

ceive that there will be a similar point, A_2, where the same condition reversed will obtain.

Again, with a change of the level the resistance will be evidently annulled by the movement assumed to be without resistance, and the intensity will be infinite. The neutralization of the inertia by the capacity will determine only oscillations of a uniform period. If these oscillations are too slow, the current in T will preponderate, and if too rapid, C will have the advantage.

There are other cases which are equally capable of demonstration by this method, but enough has been given to illustrate some of the more important conditions of electricity in motion. The illustrations are reproduced from La Lumiere Electrique.—Western Electrician.

POISONOUS GLYCERINE.

One of the most commonly used articles in domestic medication is glycerine. Glycerine is generally obtained by extraction from soap grease by acid. If this acid contains arsenic as an impurity, the resultant glycerine will also contain it—unless it has been purified by the manufacturer. The results of selling or using such arsenical glycerine were well brought out in a case that has just been adjudicated upon in Leeds, England, a synopsis of which we quote from an English exchange, together with some truthful comments.

At the Leeds police court, on July 6, before the deputy stipendiary magistrate, John Trimble, trading as Messrs. Hobson & Trimble, grocers and drysalters, 147 Kirkstall Road, Leeds, was summoned at the instance of the Leeds corporation for a breach of the Food and Drugs Act. Charles Gill, the assistant of the inspector of food and drugs (Mr. Walker), went to the defendant's shop and asked for a bottle of glycerine from defendant's assistant. The latter asked, "Is it for inward or outward application?" and Gill replied, "I want it for a friend." He was then supplied with a pound bottle of glycerine, and Walker, entering the shop, informed him of the reason of the purchase, in compliance with the conditions of the act. The assistant refused to take advantage of the offer to take a portion of the glycerine for separate analysis. The glycerine was afterward found to contain two grains of white arsenic per lb. Mr. Bairstowe went on to refer to the section of the act under which the proceedings were taken, and in reply to the magistrate said that he did not suppose anybody would take a pound of glycerine. But he did say that arsenic in the smallest quantities was injurious to health. He did not say that to take two spoonfuls would necessarily do any harm, but if a purchaser took home a bottle and allowed his child to take it, great risk would be run of injury to health. If a grown up person took the glycerine, he would possibly have to take a considerable quantity before he was seriously injured. His argument was that if a person went into a shop and asked for glycerine he had a right to expect pure glycerine, and nothing else, especially when it was labeled "pure glycerine," as was the case in this instance. Mr. Bairstowe, continuing, said that there was no doubt that in this case the article supplied was to the prejudice of the purchaser, and was not of the substance, nature and quality demanded by him. The magistrate: Was there any intimation on the bottle that it was for outward application only? Mr. Bairstowe, in reply, said that that was not the case, and that if the defendant had adopted that course, there would be an end to these prosecutions against him. William Gill, assistant to the food inspector of the city, spoke to purchasing the glycerine in question from an assistant at Mr. Trimble's shop on May 19 last. It was a pound bottle, and contained the label "warranted pure." He paid tenpence for the bottle. He was asked whether it was for outward or internal use, and witness replied, "It is for a friend." The bottle produced was then bought by the witness. Thomas Scattergood, surgeon, said that glycerine was an article of common use and a medicine. He believed it was used largely in combination with lemon juice for sore throats. Mr. Bairstowe: I suppose if it does no good, it does no harm? The Magistrate: Is it harmless with two grains of arsenic? Mr. Scattergood: I should say it would be very dangerous, if taken indiscriminately internally. A teaspoonful would contain about a fiftieth part of grain of arsenic, which would be the smallest dose of arsenic given medicinally. Mr. Bairstowe: There is an element of danger? Witness: Yes. Mr. Bairstowe: If used in making up prescriptions, would the danger be greater or less? Witness: I should say it would be greater, because it would be administered regularly. Witness was cross examined at some length by the defendant with the object of showing that the quantity of arsenic in a pound of glycerine was so small that in the ordinary course no harm would be done to the purchaser. Mr. Scattergood denied this, and said he would not like glycerine of this kind to be used in the making up of his prescriptions. Dr. Cameron, medical officer of health for the city, was next called. There was, he said, no difficulty in obtaining pure glycerine, and there was no reason why arsenic should be in it. A teaspoonful of the glycerine in question, given to a child, would contain more than the minimum medicinal dose of arsenic and would, therefore, be injurious. Of such a danger the public certainly ought to be warned. By defendant: Two grains of arsenic were the recognized quantity calculated to be fatal. Mr. Fairley, the city analyst, was called, and said it was not a proper thing for glycerine to contain arsenic, nor was it necessary for it to do so. In cross examination by the defendant, witness said that if pure acid were used in extracting the glycerine from the soap grease, there would be no arsenic in it. He was not aware that the further distillation of the glycerine would materially increase the cost. Out of eighteen samples tested by him, only seven were absolutely pure, and some of the others contained arsenic in small quantities not of material importance. The Magistrate: And you consider two grains per pound a material adulteration? Witness: Certainly, sir. This concluded the case for the prosecution. The magistrate said that, in his opinion, the case had fully been made out and the defendant would have to pay a fine of £3 and costs. In this instance the amount was two grains per lb., and the prosecution has an added importance as showing in what grave dangers unsuspected adulteration might place any innocent member of the public. Previous investigations made by the vigilant Leeds sanitary authorities disclosed the fact that the ordinary commercial glycerine on sale in Leeds contained as much as 4½ grains of arsenic per lb. It is not idle supposition that, were any wife or husband to live together unhappily, as was the fact in the Maybrick case, or to have cause for disagreement, and a bottle of this glycerine were to be found in the wife's possession in case of his sudden death, this circumstantial evidence would go very far to cause her to either lose her life or be immured in prison. So far as we are aware, Leeds is the only place where articles such as glycerine have been examined to test their immunity from unsuspected poison. Fortunately, as a result of our disclosures, it will most probably be rendered impossible that such slipshod, uncertain chemical methods as those pursued in the Maybrick case by the Crown should ever again be allowed to pass practically unchallenged in a court of justice. Discoveries like those at Leeds throw a sinister light upon the methods and upon the character of the chemical evidence that consigned Mrs. Maybrick to lifelong imprisonment. They also show the grave public necessity for a regular and exhaustive examination of all foods and drugs.

THE IODONIUM BASES.

By Christopher Hartmann and Victor Meyer.

The authors refer to p. 502 for an account of the free base $I(C_6H_5)_2I.OH$, the iodide $(C_6H_5)_2I.I$; the chloride, the bromide, the pyrochromate, $(C_{12}H_{10}I)_2Cr_2O_7$, and also the carbonate, the ferrocyanide, and ferricyanide.

The nitrate, $(C_6H_5)_2.I.NO_3$, is obtained as a white crystalline precipitate from a rather concentrated solution of the base on neutralization with concentrated nitric acid. The acid sulphate, $(C_6H_5)_2IHSO_4$, is obtained by a similar method. It is very soluble in water.

The acetate, when pure, melts at 120°, with decomposition. Its composition is represented by the formula $I(C_6H_5)_2OC_2H_3O$.

The iodonium iodide forms a beautifully crystalline addition product, obtained by stirring up the oxide with water and grinding briskly up with an alcoholic solution of iodine.

The chloride of the base forms very characteristic double salts with the mercuric, auric, and platinic iodides.

The sulphur compounds of the iodonium bases are especially interesting. The iodonium compounds are distinguished by a remarkable resemblance to thallium hydroxide and its derivatives. The hydroxide and the carbonate are alkaline and readily soluble; the haloid compounds resemble the corresponding thallium derivatives in color and solubility. This analogy raised the question whether the new bases might not form insoluble sulphides. This is, in fact, the case, and the substances formed are in aspect and general external nature deceptively similar to the recently precipitated sulphides of the heavy metals.

If a solution of the free base is mixed with yellow ammonium sulphide, there appears a dense bright orange red precipitate in large flocks, which if sufficiently concentrate causes the liquid to set into a paste. The precipitate is deceptively like recently precipitated antimony sulphide. If this experiment is performed at 0°, and if the liquid with the deposit is kept at this temperature, the new sulphide may be preserved for hours. At the temperature of a dwelling room it is unstable. If the precipitation is effected at common temperatures, the phenomena are at first the same, but in a short time the precipitate in the liquid begins to hiss and throw out white clouds of vapor; it loses its solidity, and is changed in a few minutes into a mobile oil. This was taken up in ether, dried, and fractionated. Monobenzene iodide passed over first, then followed an oil boiling at a very high temperature, which was found to be a mixture of various phenyl sulphides, a fraction passing over from 300 —325 predominating.

This oil, $(C_6H_5)_2S_3$, was phenyltrisulphide. Hence the orange sulphide consists chiefly of trisulphide—

$$(C_6H_5)_2I.S.S.S.I(C_6H_5)_2,$$

the formation of which is explained by the action of the yellow ammonium sulphide.

The normal sulphide, $(C_6H_5)_2I.S.I(C_6H_5)_2$, corresponding to the simple metallic sulphides, was obtained by means of sodium sulphide, Na_2S. If a solution of the iodonium base is mixed with a solution of this substance, there is formed a bright yellow precipitate resembling in stability the compound just described.

The reduction of the free base in an aqueous solution with a five per cent. sodium amalgam in the cold ensues according to the equation—

$$2(C_6H_5)_2IOH+4H=(C_6H_5)_2I.I+2C_6H_6+2H_2O.$$

A mol. of the base is thus resolved into benzene, water, hydriodic acid, which latter throws down a second mol. of the base as an insoluble iodide.

IODONIUM BASE AS A BY-PRODUCT IN THE PRODUCTION OF IODOBENZENES.

A formation of the base in small quantities ensues in the preparation of iodobenzene from iodosobenzene with the aid of watery vapor. This reaction takes place most smoothly if the iodosobenzene is suspended in so much water as will be necessary at 100° to dissolve the iodobenzene to be subsequently formed. If after the complete decomposition of the iodosobenzene, the contents of the distillatory flask are allowed to cool, the iodobenzene is filtered off, the liquid concentrated to about one-third, and filtered again, we find in this filtrate a small quantity of the iodonium base along with the iodobenzene.

A number of further iodonium bases are being examined in the Heidelberg laboratory.

The general behavior of the iodonium bases led to the question whether they are poisonous, and in how far they here resemble the thallium compounds. Dr. R. Gottlieb has kindly made a series of experiments in the Pharmacological Institute with diphenyliodonium hydrochlorate, and communicates the following results:

The hydrochlorate of the base produces complete paralysis in frogs. It is of peripheric character, and effects a laming of the extremities of the motor nerves and of the substance of the muscles themselves. In this muscle-laming effect, even of a small dose (0·02—0·03 grm.), and by the simultaneous paralysis of the heart muscle, the action of the base (in contrast to other organic iodine compounds) presents physiologically an analogy to some metals, e. g., lead and thallium. On the other hand, its action upon the terminations of the motor nerves approximates to that of the ammonium bases.

The action on warm-blooded animals is more complicated. In addition to the peripheric lameness there ensues here central paralysis of the spinal marrow and of the medulla oblongata, so that doses of 0·03 per kilo. occasion death by the arrest of respiration.—Berichte der Deutsch. Chem. Gesell.

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